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Notes of the Month.

Our series of articles on "Science and Religion" ended officially in the July number of *Discovery*. Professor Julian Huxley's interesting and provocative list of questions in our September issue, however, has been the source of a great deal of varied correspondence, in which many points of view have been expressed. As a fitting close to the discussion of this profoundly important subject, Dr. Alfred Noyes has agreed to contribute a concluding article, which is to appear, appropriately enough, in the last issue of the current year. It will not come as a surprise to those who are familiar with his work, to learn that Dr. Noyes's attitude differs widely from Professor Huxley's.

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Dr. Noyes writes: "The difficulty with Professor Julian Huxley is that he seems to have the specialist's unawareness of the quality of thought that has been given to the more philosophical aspect of these questions for many generations by the outstanding philosophers of Christendom (his own grandfather, despite his agnosticism, answers him on several points). Every point he tries to make has been made by Christian thinkers from St. Augustine onwards. Here is a short extract from a great Catholic writer, for instance: 'The one principle implied in every scientific investigation is the principle of phenomenal uniformity. If some deity had the power or will to affect the fixed laws of Nature, Science would be an impossibility. Those scientific achievements, then, which the most religious man cannot attempt to question afford an absolutely irrefragable demonstration of that first principle. No investigations proceeding on a false basis could have issued in an innumerable multitude of experimentally true conclusions.' Could Professor Julian Huxley have stated it more strongly?"

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"My point is," Dr. Noyes continues, "that Professor Julian Huxley doesn't seem to be aware of the height, depth and complexity of the thought he has to meet, and he chooses *his* points in a way that would necessitate a restatement of what he, in common with every cultivated man (scientist or humanist), must know. There is all the difference in the world between the mathematical religious theories of Dr. Barnes, against which Professor Huxley's arguments are completely valid, and the far more profound philosophy of humanists like Dean Inge or Von Hügel. There are no grades like those of religious 'thought' in the scientific world; an uneducated man cannot be deeply scientific; but he *can* be deeply religious, even though he lacks all philosophical training. But it is difficult to answer questions satisfactorily until the height and depth of the real problem is envisaged by the questioner."

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A further important Derbyshire property of 28 acres near Rowsley and Haddon Hall has been given to the National Trust by Mr. F. A. Holmes of Buxton. It is the bold gritstone escarpment of Stanton Moor Edge situated 900 feet above sea level, forming a natural terrace a mile in length, surrounded by heather-covered moors and commanding a view of unrivalled grandeur. Interesting villages surround the new National Trust property; Birchover, where cylindrical millstones are made and sent far afield for the manufacture of wood pulp for paper, is situated on the edge of the Moor.

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On the Moor are several huge irregular masses of gritstone of grotesque shapes; and the whole area abounds in evidences of ancient civilisation. Stone

circles, round barrows, rocking-stones, altars, and sacrificial basins, and at varying periods there have been discovered cinerary urns, incense cups, lamps, bronze fibulæ, bronze celts, pottery, flint arrowheads, and axe hammers. These are to be seen in the Buxton, Derby, and Sheffield Museums, and in the private collection of Mr. J. P. Heathcote of Birchover. Important archæological finds are still being made.

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The question of scientific nomenclature is a very delicate matter, and one which we have no intention of entering into here. One example of the difficulty arising out of sudden and often unnecessary changes of name, however, affects us more closely. In Mr. Crossland's article on "Strange Fishes of the Red Sea," in our October issue, a remarkable fish with tubular suctorial mouth and elongated dorsal fin was illustrated, entitled *Amphisile scutata*. It now appears that the name has been changed to *Æoliscus punctulatus*, Mr. Crossland having been advised of the alteration by the British Museum authorities.

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The problem of determining exactly which of the various willows grown in this country will give satisfaction for the manufacture of cricket bats has been under consideration by growers of willows and makers and buyers of cricket bats for some considerable time. It is not a simple one, as, in the past, makers of bats, when buying trees, have been more concerned with bark characters and general appearance than with the botanical identity of the trees selected. The Forest Products Research Board is collaborating with the Imperial Forestry Institute, the Forestry Commission, willow growers, and bat makers, in an endeavour to determine the most suitable species, varieties or hybrids, the optimum soil conditions for their growth, and the sylvicultural treatment necessary to ensure first-quality trees. The growth features of certain trees selected for test are being examined, and a detailed investigation of the wood structure will be carried out, with mechanical tests to determine the strength properties. It is hoped that some definite relation may be established, linking results obtained in the laboratory with the opinion of players on the quality of bats made with the timber so tested. For the mechanical tests material was taken from six localities early in 1933, and the clefts, which were left to season through the summer and autumn, are now ready for testing. Twin clefts to these are being made into bats for tests in play.

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In our last issue Mr. Eric Hardy gave a graphic description of the way in which wild birds are adapting themselves to urban and suburban conditions. Everyone is familiar with the stories of blue tits nesting in letter-boxes, old boots, and so forth, but it is only comparatively recently that the larger hedge-nesting birds have reconciled themselves to the disappearance in many places of their customary nesting-haunts. The accompanying photograph, reproduced from the *Glasgow Daily Record*, illustrates the strange nesting-place of a blackbird. The nest has been constructed on a varnish-tin on the shelf of a Glasgow outhouse. Unaccustomed surroundings appear to have little effect on the fledglings' appetite.

One solution of the housing problem.

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Attention is drawn to certain alterations which have been made in the method of subscription by non-members to the Afternoon Lectures at the Royal Institution. In future single lecture tickets will be sold at a charge of 3s. each. The new arrangements apply to all the Afternoon Lectures except the Christmas Lectures. Subscribers to a course of lectures will receive a book containing the appropriate number of single lecture tickets for the course.

Termites.

By Malcolm Burr, D.Sc., F.R.Ent.S.

It has been estimated that in the United States alone, termites are responsible for no less than 37 million dollars' worth of damage a year. The results of the work done by the Termite Investigation Committee have just been published by the University of California. The research has largely increased our knowledge of these insects. Dr. Burr gives a brief account of their remarkable economy.

About 1928 the Californian public began to realise that wood-boring insects were doing considerable damage. Telegraph poles, timber stacks, wooden buildings and frames of the type recommended for earthquake regions, floors, furniture, all wooden structures, even stationery and books were found to be corroded, riddled, and weakened to the point of collapse, if not actually destroyed. Everything containing cellulose was found to be infected. Appeal was made to the entomologists, who replied that, apart from some trifling damage done by wood boring beetles, carpenter bees, and perhaps some lepidopterous larvæ, the villain of the play was the termite. They dismissed the popular notion that the trouble was due to an invasion by some foreign pest, and pointed out that the harm was done by a native of the state with a far longer history than their own, far older, indeed, than mankind. It was done by indigenous termites, for the warm, moist climate of the Pacific coast, together with contiguity with the vast fauna of the Neotropical Region, has given that part of the United States a fauna unusually rich in termites, often miscalled white ants, an ancient and structurally primitive order of insects, the *Isoptera*.

Earthen mound built by nasute termites in northern Australia.

In these islands we are singularly blessed, as this order is not represented. In the south of Europe there are only two species, but in the United States there are no less than fifty-five, the majority limited to the Pacific Coast. When man began to artificialise conditions, there occurred the inevitable clash of interests, the termite, in the fulfilment of his task of destroying wood, coming into conflict with man, who wishes to preserve it.

When the Californian public realised the situation, they rose to the occasion. A Termite Investigation Committee was formed and finance provided, under the ægis of the University of California, which has now produced an elaborate and extremely interesting Report*, the work of no less than thirty-four authors, a new edition of which is promised for Autumn, 1934. While the practical part, dealing with the prevention and repair of termite damage, is of great moment to architects, engineers, surveyors and contractors, the biological part is of great interest to entomologists.

The termites are morphologically primitive insects related to the cockroaches. Following a course of evolution based on their special function of breaking up cellulose, which is refractory to most natural processes, termites have developed a cryptobiotic method of life, which renders vision superfluous, and a highly elaborate organisation in many ways comparable with that of the social Hymenoptera, which may excuse the common confusion with the ants, at the other end of the evolutionary scale of the Hexapoda.

Among the 1,500 or so known species of termites, there are many forms of life differing in detail. The chief family, the *Termitidæ*, with about 1,200 species, includes the builders of those spectacular tropical fortresses which have made them famous. This family does comparatively little damage. Indeed, contrary to

* *Termites and Termite Control*, a report to the Termite Investigation Committee. Edited by Charles A. Kofoid, S. F. Light, A. C. Horner, Merle Randall, W. B. Herms, and Earl E. Bowe. (University of California Press and Cambridge University Press. 22s. 6d.).

Reproductive alate (left) and large-headed soldier: two castes of the common damp-wood termite.

the prevailing belief that they are an unredeemed nuisance, they do quite useful work, like that of the earth-worms of the temperate regions, breaking up the soil, and aerating it. The material of their fortresses, termite earth, which is comminuted soil bound with their saliva, is largely used in Africa for making the well-known so-called Kimberley bricks, and in sandy regions, as in parts of the interior of Angola, affords the only coherent material for binding road and other surfaces. The sandy soil of that region, apparently so barren, contains enough nourishment to support a vast forest, which is rendered possible only by these insects. These beneficial aspects of the termites have not come before notice of the Committee and so are not dealt with in the Report. The remaining 300 species are divided into four families. For practical, but not scientific, purposes, they may be divided into categories according to their habits, as follows:

(i) Dry-wood termites.
(ii) Damp-wood termites.
(iii) Earth-dwellers.
  (*a*) Subterranean.
  (*b*) Desert.
  (*c*) Mound builders.
  (*d*) Carton-nest builders.

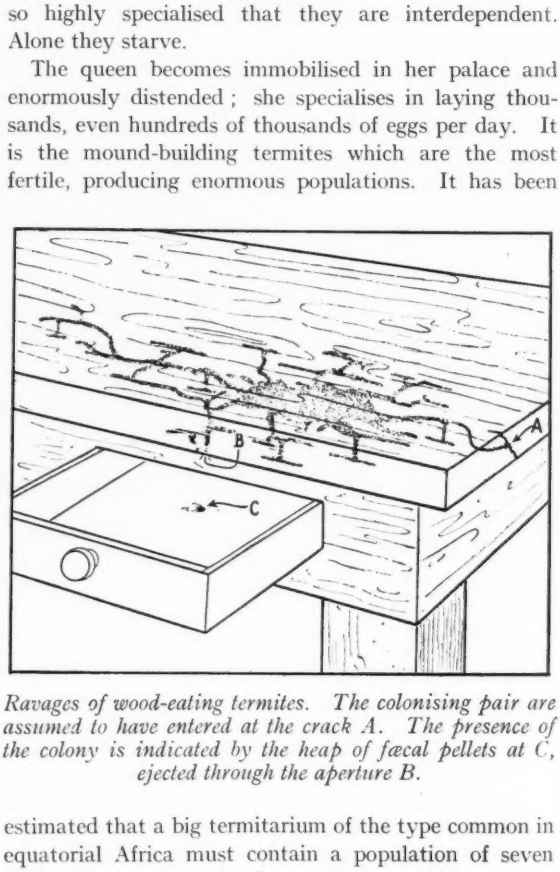
It is the subterranean types that cause the greatest damage.

Biologically, they are of extreme interest. Like the social Hymenoptera, they have evolved several castes, but the resemblance of their social organisation is only superficial, as in the termites both sexes are equally represented in the castes; and, unlike the Hymenoptera, which are matriarchal, the termites are gynandrarchic, having kings as well as queens. With the ants, mating is effected but once, and the queen fertilised for good, but the termites at swarming time are not yet sexually mature and mating does not begin until later. Moreover it continues throughout the royal life. Another point of difference is that there are no solitary termites.

The division into castes is elaborate. There are three categories, the alates or reproductives, the workers, and the soldiers, and three phases of each, primaries, secondaries, and tertiaries, making nine in all. If we add the stages of growth of larvæ and nymphs, there is considerable diversity of form in a colony.

Reproduction is the privilege of the restricted caste of alates. Typically, there is but a single pair in a colony of about 100,000, but to destroy a colony it is not enough to destroy only the royal pair, as reserve queens are available, capable of developing into royalty if required by the death of the reigning monarch. The castes are so highly specialised that they are interdependent. Alone they starve.

The queen becomes immobilised in her palace and enormously distended; she specialises in laying thousands, even hundreds of thousands of eggs per day. It is the mound-building termites which are the most fertile, producing enormous populations. It has been



Ravages of wood-eating termites. The colonising pair are assumed to have entered at the crack A. The presence of the colony is indicated by the heap of fæcal pellets at C, ejected through the aperture B.

estimated that a big termitarium of the type common in equatorial Africa must contain a population of seven million, or even more. In temperate regions colonies may consist only of a few thousand, or even hundred, individuals.

Once a year, when conditions are favourable, there is an extraordinary reversal of instinct, marked by great

excitement in the colony. Negative phototropism becomes positive. Doorways are broken in the walls of the fortress and the winged reproductives seek the light in countless thousands. Atavism asserts itself and for a few weeks they revive their ancestral free-living life in a mad love-dance.

Extraordinary scenes are witnessed when this swarming takes place. They emerge simultaneously over a great area and so their numbers are almost incredibly great. They may arise in clouds which darken the sky in the afternoon. They may make life a burden, dropping in thousands into food and drink, entering clothing in numbers, and making it impossible to sit and work in a lighted room. The muffled fluttering sounds like snow. It is then that in countless thousands they fall a prey to all insectivorous animals, ants, birds, lizards, bats, rats, and even man. In Africa I have watched a swarm emerging from the ground in the middle of the dry season, which seems to be an exceptional period, in clouds, attracting numbers of birds from a thinly inhabited forest. The Report gives a vivid picture of the swarming of termites in California.

A young camphor tree from California sectioned to show the borings of a subterranean termite.

Millions must be devoured, but a single surviving pair can found a new colony. On settling, the wings break off along a natural suture near their base there is a reversal back to negative phototropism, that is, they revert to the normal conditions of their present-day life. When a pair settles upon a piece of wood, dead tree, or furniture with a flaw, and penetrates it and founds a colony, that piece is doomed. The colony will quietly consume the inside, leaving always the outside shell intact, until the structure is ready to collapse at the slightest shock.

A colony once established is theoretically immortal, owing to the presence of reserve royalties. When the king or queen dies, out of the available nymphs supplementary reproductives are developed to replace them. This does not take place so long as these nymphs are in contact. It seems that the mature reproductives secrete some substance, transferred by licking and food passing, that inhibits sexual maturity, In America there is no evidence of senescence or death of a termite colony. It does occur, however, in Africa, as observed by Nazaroff and myself (Geol. Mag., lxviii, p. 443, 1931 ; also Ent. Rec., xliii, 1931, p. 81). We found semi-fossilised termitaria preserved in ironstone and in one case silicified.

The mound-building kinds make fortresses many feet high—indeed, the largest structure made by any animal except the corals. The age of such colonies must be very great ; often they have quite big trees growing upon them. In poor soil, in the Luano Valley in Northern Rhodesia, I noticed that occasional termites' nests carried a richer flora differing from that of the surrounding soil.

The termites' work is so concealed that the damage done is often not revealed until too late. Their secluded life protects them against their enemies, the chief of which, in temperate regions, are ants, though they are attacked by ant-eating animals in the tropics, such as the aard-vark in Africa, which easily digs himself into the nest with his powerful talons and makes his home there. They are protected even against other colonies of their own species and in the rare event of a chance meeting, members of different colonies show antagonism, but they recognise members of their own tribe by odour. When two of them meet, mutual greeting takes place, as they groom each other, removing dust and mould, as do ants, yielding each other the desired exudates.

Their system of defence is organised against their chief enemies, the ants. There is considerable variety of method, but the work is the duty of the soldiers. These may flick dust in the face of the invaders, or even plug runways or breaches in the walls with their enormous heads. Chemical warfare is highly developed. They use a milky juice that entangles as well as stupefies, and an acid secretion so corrosive that it will etch metals and eat a way through lime mortar. It is a curious thing that, while the workers have powerful mandibles as tools for shearing shaves of wood, the soldiers have lost theirs, and as weapons of offence and defence have enormous heads, often with long snouts, and the chemical glands. In rare cases where termites forage in expeditionary armies, which may number millions, the columns are escorted by soldiers, which race in both directions. Incidentally,

this type of termite is darker and harder than the enclosed ones; they are, too, longer on the legs, more spidery, and often mistaken for ants. This type does not attack wood and is economically of little importance.

From the point of view of the insect, the isolation of each colony has the advantage of restricting epidemics. It also protects them against extremes of temperature and humidity and gives them facilities for prolonged and continuous work. Their tremendous powers of propagation increase their destructiveness. The ability to store, and even create, moisture makes the dry-wood termite independent of the ground, so that it can live in desert regions. During a prolonged drought in South Africa in 1828, suffering sheep-farmers realised that the termitaria still contained moisture, and so sank wells alongside. According to newspaper accounts, they found that the insects had sunk a shaft of about the diameter of a pencil down to a depth of fifty feet, where they had struck moisture. The shaft was filled with two columns of workers, one going down empty, the other returning, each insect laden with a drop of water.

Their power of digesting cellulose is not properly understood, but one remarkable fact appears to be undoubted, that they owe it to the presence in their intestines of a rich fauna of parasites. The excellent work done upon this subject by Cleveland shows that it is definitely a case of symbiosis, that is of partnership for mutual benefit, the parasites, in return for a comfortable home, enabling their hosts to extract the rich supply of chemical energy stored in the cellulose, a power which has given the termite an abundant and continuous supply of food for which there are few competitors.

The Essential Parasite

The fluid contents of the hind intestine are a seething mass of active *Protozoa*, *Spirochæta*, and bacteria. All four classes of *Protozoa* are represented, but the most numerous are the *Flagellata*. Many of the *Protozoa* have internal parasites of their own, bacteria and simple fungi. It is instructive that in the *Termitidæ* which feed upon humus and vegetable detritus, *Protozoa* are few in number and often absent. But, of the 300 species that consume cellulose, about one-third have so far been examined for *Protozoa*, and they have all been found to be infected, so it is highly probable that all members of these three families have a rich and abundant fauna. When a termite moults, the fauna is lost with the cast skin, but it is quickly recovered by contact with neighbours, the exchange of droplets, eating of fæcal droppings and so on. It has been shown that if the *Protozoa* are eliminated, the termite will slowly die of starvation, but if reinfected, it will recover. The parasitic Spirochætes do not appear to play any specific role in the life of the termite and are probably merely commensal. Of the *Protozoa* it is known that they partially digest the cellulose for their hosts, and probably a bacterial flora helps occasionally.

A very interesting consideration arises in this connection. Almost all termites of a given species contain the same characteristic fauna. Also, it is extremely doubtful whether transfer ever occurs from one host species to another. From this arises the assertion that, no matter where a given species of termite occurs, examination of the gut will almost always reveal the same fauna of *Flagellata*. Some genera, even subfamilies, have a distinctive fauna. Thus the *Protozoa* are of great assistance in showing the true relationship of termites and a great help in classification. H. Kirby makes the significant statement that similar *Protozoa* are found also in the wood-boring cockroach *Cryptocercus punctulatus*, and that in the cockroaches the Flagellate genus *Trichonympha*, which is widely spread among the termites, is represented by several species. The clear implication is that the *Protozoa* have come down unchanged from the common ancestor of the termites and cockroaches, which are believed to have diverged about the end of the Palæozoic Era.

The Termites' Garden

There is also an association with fungi, from which no colony in any kind of wood is entirely free. The fungi may help by breaking down the structure of the wood and so facilitating attack by termites. They are certainly eaten by them, but the significance of this is not known. It certainly seems that the presence of fungi in wood is important for them, as the mound-building kinds make gardens of comminuted wood, in which they cultivate fungi. The function of the fungus is probably the fulfilment of the protein and vitamin requirements of the insect.

These seemingly ineffective creatures dominate whole areas in the tropics. In the Congo I have seen their massive fortifications, 15 feet high, perhaps even more, often so closely packed that there was no space between them. By sheer force of numbers, combined with astonishing social organisation, they dispute man's mastership of the tropics and increase the cost of his conquest by at least ten per cent. "Their extreme sensitiveness, the high degree of innervation, even of the mandibles, compensates the absence of sight, so much so that the co-ordinated behaviour of their complex social life seems to have permitted the individual to benefit by experience and to have raised their level of behaviour in some of its aspects to intelligence." So writes Dr. Kofoid, Editor-in-Chief of the Report.

Astronomy and Modern Thought—II.

By the Rev. T. E. R. Phillips.

In this, the continuation of his Fison Memorial Lecture, the author explores the philosophical meaning of modern scientific thought. The Fison Lectures are delivered annually at Guy's Hospital Medical School in Memory of Dr. Fison, Lecturer in Physics, whose untimely death in 1923 *was so great a loss to the School. Their scope is the philosophical aspect of Science in the widest sense.*

I MUST now leave my outline sketch of modern astronomy and devote the time remaining to me to the second part of my subject, the bearing of our new knowledge of the universe on present-day thought. I feel I am somewhat rash in attempting this, and yet the *rapprochement* of Science and Philosophy is undoubtedly one of the features of this present time. That the two should ever have drifted apart was, of course, inevitable. There could have been no progress, no development of Science whatever so long as the human mind was dominated and controlled by a rigid and static philosophy, which everyone now recognises to have been on wrong lines. It was essential that the principle of experiment or the direct appeal to Nature should be substituted for the slavish acceptance of the dicta of past teachers however eminent. Accordingly, we hold in high honour those who dared to doubt and to ask questions, and who heroically, at the cost of personal suffering and loss, fought for and won the emancipation of science from its bondage to an out-worn authority. But although recognising the defects of mediæval philosophy, we must not forget what we owe to the Schoolmen in regard to the principles of accurate thinking and reasoning which they elaborated with such care. Logic and the systematic organisation of knowledge are the very sinews of science, and if, on the one hand the mediæval philosophers hindered its advance, on the other they helped to provide the conditions for its progress. And now science and philosophy are coming together again. Each has learned valuable lessons and has something to gain from the inspiration of the other ; and is it not in the association of the two that we have our greatest hope of a closer approach to that great desideratum of the human mind—the knowledge of reality ? Let us then consider one or two respects in which modern thought has been modified by recent scientific discoveries and theories.

The Advent of Relativity.

Until near the end of the last century the scientist's creed was definitely *materialistic*. Matter was composed of minute hard particles existing in a universe of absolute relations, quantities, and forces, and controlled by a rigid system of physical " laws." But Relativity and the Quantum Theory have come and changed profoundly our beliefs. Even the all-pervading ether has been taken from us save as an abstraction. It has been reduced to the mere metrical space-time frame-of-reference in which we locate or measure phenomena and events. The hard solid atoms of Democritus and Dalton have dissolved into electric charges which would appear to be little or nothing more than certain configurations or warpings in the space-time continuum. Our standards of length, duration, and mass hitherto assumed to be absolute and invariable, turn out to be dependent on relative motion, while even force has disappeared save as a manifestation of certain static metrical properties of space-time. Only in the four-dimensional world in which the three space dimensions of our common experience and time are inseparably blended together does the absolute seem inviolate. It follows then, that materialism in the old sense of the word is out-of-date. As an attitude of mind towards the external world, or as a philosophy of life or conduct, " materialism " may survive, but as a philosophy of Nature herself—unless we give the word a new meaning—it seems to be impossible. If it be argued that of course matter is matter still, whatever we may think about it, it is none the less true that it has lost its old substantiality and is found to be very different from what men throughout the ages have believed it to be.

The Failure of Determinism.

Another conception which has a hard struggle to maintain itself to-day in its old form is that the Universe is like a great machine set going somehow in the remote past and working towards a predetermined end. In the 19th century especially was it sought to explain all the phenomena of Nature in terms of mechanics. " I never satisfy myself till I can make a mechanical model of a thing. If I can make such a model I can understand it." So wrote Lord Kelvin. But the belief in a rigid determinism has been greatly shaken by recent discoveries and theories. The phenomena of radio-activity, the behaviour of electrons within the atom, the puzzling facts summed up in Heisenberg's " uncertainty principle " (in accordance with which it is impossible at the same moment to define both the position and the motion of an electron as it whirls around its attracting proton),

and other mysteries encountered in the study of radiation and wave-mechanics, all present facts which many of our leading physicists find it hard, if not impossible, to reconcile with strict causation, or that mechanistic view of Nature which was once believed to be so firmly established. A change has accordingly taken place in their beliefs concerning what is commonly termed natural " law." We have always recognised, of course, that the formulation of a " law of Nature " has something arbitrary about it. It is necessarily descriptive and not prescriptive, and if it prove to be inaccurate or inadequate it can and must be amended accordingly; but all the same there has probably been at the back of most minds the belief that there is something akin to necessity in the actual phenomena the law has been invented to include. Is not the " uniformity of Nature " after all the very basis of scientific knowledge, and are not " cause " and " effect " always associated together? But now, it seems even this is uncertain and it is suggested that the observed uniformity is merely *statistical* in character, that like the law of averages the laws of Nature apply only to particles in the mass or in crowds, but break down when we come to consider the behaviour of individual atoms or electrons or other minute units of Nature. On the other hand we must remember that there are great physicists like Einstein and Planck who demur to this new view, or the readiness with which it has been adopted on what they hold to be inadequate evidence. They regard the prevalent doubt concerning strict causality as a mere temporary " asylum of ignorance " and anticipate the eventual reinstatement of the old doctrine. We shall probably do well to maintain for the present an open mind on the point at issue, however much the new view may be in accord with our natural preferences and our own sense of personal freedom.

An interesting suggestion has been made which, perhaps, throws some light on the difficulties encountered by the modern physicist. Those phenomena taking place within the atom which seem to be outside the common order of nature and can only be expressed in mathematical symbols—is it possible that they are indications of something happening in another order—such as a fourth space-dimension—of which we can have no direct apprehension?

Adventures of a Square.

No doubt some of us remember a book written many years ago bearing the title *Flatland*. In it was described the experiences of a two-dimensional being—a Square—whose own world was a mere surface and its inhabitants, its houses and all other objects plane geometrical figures. In vain did the square try to enlighten the mind of a being who lived in " Lineland," and who could only move and perceive along a straight line, while it was utterly impossible for him to rouse from his self-complacency the inhabitant of " Pointland " whose whole universe was comprised within his own being—a single point! On the other hand the Square himself became violent when his home was invaded one day by a Sphere from the three-dimensional world. Not through the doorway of the Square's house did he come but as it seemed mysteriously from nowhere, and strangely indeed did the diameter of his circular section vary as he bobbed up and down across the plane of the Square's world! But the Square was compelled against his will to undergo a wonderful experience. He was forcibly taken up out of his superficial world into the world of space! He saw things as he had never seen them before and never could have pictured them, and he went back to his home in Flatland to preach to an unbelieving and persecuting world the gospel of the *third dimension*. We have already thought of the Universe as like an expanding bladder. If for that bladder we substitute a football, what strange and inexplicable things would any two-dimensional beings living on the surface of the latter experience as the players of the three-dimensional world kick it to and fro about the field of play!

How many Dimensions?

And what if some of those mysterious happenings in physics which seem so inconsistent with the rules of our familiar world should have their origin in a fourth space-dimension? Indeed how can we place any limit to the number of dimensions there may be, or claim that the Universe of our experience is more than a limited portion of the whole?

To go back for a moment to our converted Square—it is related that in the task he took upon himself of trying to persuade his former teacher—the Sphere—that there must be other and innumerable dimensions, he spoke of space beyond experience as " Thoughtland." And here we are reminded of the revival of idealistic views of Nature of various types and degrees, which are replacing in our days the materialistic and mechanistic outlook of the 19th century physicists. Bishop Berkeley seems to be coming into his own again. Commenting on the apparent breakdown of mechanical and deterministic theories Sir James Jeans says: " The stream of knowledge is heading towards a non-mechanical reality; the Universe begins to look more like a great thought than like a great machine." Sir Arthur Eddington, in writing of the selective influence of the mind in the relation between the world of physics and that of our everyday experience, says: " Not once in the dim past, but continuously by conscious mind is the miracle of the Creation wrought." Bishop Barnes, who describes

himself as a moderate realist, says: "I conceive that our minds do not create the world inasmuch as it has its being in God; it would be what it is were there no finite centres of consciousness, such as ourselves in the Universe. But we contribute something—how much we do not know—to the making of the world as it appears in the concepts which constitute our public knowledge. Thus the world *as we know it* has not an independent objective existence."

Another interesting outcome of recent discoveries and new theories is the development of Holism in modern philosophy. The whole is something more than the mere sum of its parts. Philosophers like A. N. Whitehead, J. C. Smuts, and others lay stress on the concept of organism as a fundamental feature in Nature. Mechanism has, of course, its contribution to make but the relations of the several parts are nevertheless ultimately controlled by the directive purpose of the organism as a whole. It is this principle which underlies the various concepts of creative or emergent evolution so prevalent in philosophy to-day.

The Divine Order.

It would not be proper to conclude this lecture without a reference to that which has always held a large place in man's thoughts and intellectual activities, viz., Religion. It is true that the conclusions of physical science are not necessarily of critical importance to religion as such. They may be so to those pantheistic forms of it in which God is thought of as emerging with the Universe in the process of its evolution and may be supposed to end with it—if it does end. But if we believe that God transcends though immanent in, a universe which is His creation, then we can conceive the beginning, development, and ending of the latter like any other series of events as taking place in the order of spatio-temporal relations while the universe itself stands in its altogetherness an eternal fact in the Divine Mind and other minds which share the knowledge of eternity. Christianity, at any rate, seems always to have contemplated an order, figuratively described as "a new heaven and a new earth," which is to be experienced when "the first heaven and the first earth are passed away." We may, then, concur with Dean Inge when he says in his book *God and the Astronomers*: "The fate of the material Universe is not a vital question for religion. In philosophy it does matter, because if entropy is true some philosophies are in ruins." But we cannot leave the matter here. The amazing extension of our horizon and the new concepts which have come into physics can hardly fail to react in some way on the beliefs and hopes in which many of us have been brought up and nourished.

For instance, our knowledge of the vast extent of the Universe would seem to make the old geocentric attitude of mind, which has dominated religious thought in the past, impossible. Even if we accept Jeans's view that the formation of planetary systems such as ours is a comparative rarity, we can hardly suppose—at any rate we have no right to assert—that a Divine revelation is a fact which we uniquely enjoy. It is reasonable to believe that wherever there is intelligence—and there may be greater intelligence elsewhere than here on Earth—there too is communion between the Supreme Creative Mind and His creatures.

On the whole it may be said that the relations between science and religion are far more friendly than was the case in the last century when they were often in open conflict. The fact is, religion has become broader and more tolerant and science less aggressive and far less assured in many of its assertions than it was. How indeed could it be otherwise? For if on the one hand the enforced acceptance of new facts concerning the Universe has necessitated the re-interpretation of fundamental religious beliefs in the new light thrown upon them, and the abandonment of merely external dressings belonging to former centuries, on the other the breakdown of seemingly impregnable conceptions in physics, the mysteries of quanta, the apparent illogicality and seeming indeterminacy found at the heart of Nature, have shown how much there is which is yet beyond the understanding of the keenest intellects, and how great is the need of caution and reserve in scientific statement.

As a matter of fact nothing is more characteristic of present-day science than the way in which caution is combined with daring in the use of the imagination.

Beyond Science.

We have recognised that science and religion represent different activities of the human mind; and it is quite properly urged that science must maintain its search for truth without the hampering effects of any philosophical or religious dogma. But after all the things which matter most to us are of the kind with which science, with its clocks and scales, its pointer-readings and measurements, is not concerned—those things which are ours because we are something more—very much more—than merely physical beings.

We live in a world of values, we have our emotions and our ideals, we can reason and plan, we can and do to a large extent create our own environment, we appreciate the good, the beautiful, and the true, and it is in our relations with this other world, with all it connotes of partnership with the Infinite Mind, of which the physical universe is only one and a partial manifestation, that we may look to find our truest selves and realise our destiny.

Travelling Light.

By Major A. P. Le M. Sinkinson.

The future of the railways still hangs in the balance. Professor Hallsworth, at the recent British Association Meeting, outlined a scheme for their economic salvation; Major Sinkinson here considers the railcar as a possible solution of the passenger problem. The questions of speed and lightness are certainly settled; whether the travelling public can be educated to do without "empty carriages" and other luxuries of the rail is a different matter.

THE term railcar is a convenient one to apply to the fast self-contained passenger units now running on many of the world's railways. A railcar is generally, though by no means always, propelled by one or more Diesel engines driving a dynamo on the oil-electric principle. Its general application may help to restore the prosperity of the railways, which have suffered exceedingly in recent years from road competition, and are now faced with the rivalry of the air as well. Some interesting types of railcar were described in *Discovery*, in October last year, but considerable advances have been made since then in this type of passenger vehicle.

Compared with road services, the railways have the advantage of speed, which becomes more pronounced the greater the distance, though passenger fares by road are usually cheaper than third-class railway fares. Compared with air services, the railways are at a disadvantage in point of speed, which also becomes more pronounced the greater the distance; but they are much cheaper, passenger fares by air being usually higher than first-class railway fares.

New Developments in Speed.

In meeting this twofold menace the railways generally have replied with additional cheap-fare facilities, much more comfortable carriages, and faster trains. In recent years the French have accelerated many of their expresses. In this country passenger train services have been speeded up so vigorously that in the summer of 1933 the British railways had a 55 miles an hour start-to-stop mileage of over 20,000, or very nearly as much as all the railways of the Continent put together. In 1934 the German railways made some striking accelerations in the schedules of their steam-hauled expresses. But even this enterprise is not enough to stem road and air competition.

The steam-hauled express train appears to be approaching its limit of speed. Disregarding the isolated claim of the G.W.R. to a record speed of 102.3 miles an hour attained momentarily by a special train down a sharply falling gradient in 1904, we can refer to well-authenticated instances of maximum speeds of between 92 and 93 miles an hour attained, curiously enough, by locomotives on all four British railways. This uniformity of maximum speed by locomotives of widely varying design does suggest that 93 miles an hour is the absolute top limit of speed attainable by a locomotive. It is not possible to make comparisons with foreign railways, since in most countries abroad there is a speed limit of 120 kilometres (74.5 miles) an hour, more or less strictly observed, whilst American speed claims have to be taken with a grain of salt. In the summer of 1934 the world's three fastest start-to-stop schedules for steam-hauled trains were as under:

TRAIN.	From	To	Distance	Time (mins.)	Speed m.p.h.
G.W.R. Cheltenham Flyer..	Swindon	Paddington	77.3	65	71.4
Paris-Orleans—Sud Express	Poitiers	Angoulême	70.0	60	70.0
German Railways	Berlin	Hamburg	178.1	154	69.4

The fastest start-to-stop run on record by any type of train is that on the G.W.R. Cheltenham Flyer on June 6, 1932, when the 77.3 miles were covered by a locomotive of the Castle class, drawing a train weighing 195 tons, in 56 minutes 47 seconds, at an average speed of 81.7 and with a maximum speed of 92.3 miles an hour. Such speeds are possible only with comparatively light loads on tracks free from service and other slacks. An exceptionally meritorious run with a fairly heavy load was that of the L.M.S. up Mancunian on July 18, 1932, when a locomotive of the Royal Scot class, with 375 tons behind the tender, ran the 176.9 miles from Wilmslow to Euston in 165 minutes 15 seconds (booked 172 minutes), inclusive of service slacks at Crewe, Stafford, Polesworth, and Rugby, at an average speed of 64.3 miles an hour, and with a maximum of just over 82. When trains exceed 400 tons or so, very high speeds become next to impossible. Many expresses on the L.M.S. and G.W.R. now load up to 500 tons or over (the 15-coach Royal Scot weighs normally about 490 tons laden); and loads exceeding 600 tons are not unknown on the L.N.E.R.

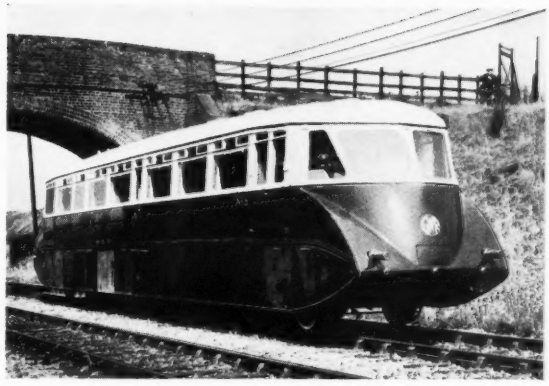
Three Tons per Passenger.

The weight of the modern express train has become a problem of the first magnitude. Since the end of the 19th century trainloads have steadily increased, due to the provision of better coaching-stock, including restaurant and sleeping cars of both classes. The late-Victorian non-corridor six-wheeler accommodated 24 (or 32) first-class or 50 second- or third-class passengers,

and weighed 12 or 13 tons. Five or six of these vehicles, with one or two ten-ton brake-vans, constituted a normal train (innocent of restaurant or buffet car), weighing 80-100 tons. The latest L.M.S. third-class corridor coach of seven compartments seats 42 passengers, each provided with arm-rests, and weighs empty 31-33 tons. Most express trains are equipped either with dining cars weighing up to 45 tons apiece, or else with sets of three vehicles (first-class saloon, kitchen car, third-class saloon), weighing close on 100 tons. Modern sleeping cars weigh from 33 to 45 tons each. Thus the weight of a modern express train has grown out of all proportion to the number of passengers carried, the weight per passenger approaching one-and-a-half tons, or two tons, including the locomotive. On the Continent the latest steel-framed corridor coach turns the scale at 60 tons, so that a ten-coach French or German express is as heavy as 600 tons. In the U.S.A. the corresponding coach may weigh as much as 70 tons, and a complete train over 1,000 tons, yielding a weight, including the locomotive, of nearly three tons per passenger.

It is obvious that dead weight to this extent is in the highest degree uneconomical, and that something must be done to surmount the difficulty. Passengers by road have become accustomed to travelling in relatively light vehicles with the minimum of luggage-space and no restaurant facilities (if we except the primitive buffets provided on some coaches). Air passengers can obtain meals, but their luggage has to be scanty. In both cases they are satisfied with one comfortable seat, in which they remain until they reach their destination. They are unable to walk about their conveyance and take their meals in a separate restaurant car during the journey. Nor do they expect separate compartments, being quite content with an open saloon. Dead weight is cut to a minimum. Why should not the railways do the same? The answer is provided by the railcar.

The most famous railcars in the world are perhaps those working the Berlin-Hamburg service. The Flying Hamburger railcar is a unit consisting of two articulated coaches driven by two Maybach Diesel engines of 820 h.p., having a maximum speed of just over 100 miles an hour, and accommodating 102 passengers (all second-class). A buffet is provided and there is room for light luggage. The entire unit, including the engine, weighs only 77 tons, or very little more than one German standard corridor coach. The weight per passenger works out at about three-quarters of a ton. A corresponding steam-hauled train accommodating the same number of passengers would weigh, including the locomotive, between 220 and 250 tons. The Flying Hamburger's maximum speed, only 7-10 miles an hour faster than that of the modern steam locomotive, does not



[*By courtesy of the Great Western Railway.*

Great Western streamlined railcar, with a maximum speed of 75-80 miles per hour.

appear to give it a preponderating advantage over its more conventional rival; but the Diesel engine gains enormously in its powers of acceleration and hill-climbing, due partly to the inherent qualities of the internal combustion engine and partly to the relatively light weight of the Diesel unit. A steam locomotive, even with a load as light as three coaches, takes a long time to get into its stride, and is gravely affected by service slacks and signal checks, the slightest of these costing from two to three minutes, and severe checks six or seven. Further a gradient of 1 in 100 (such as the Sole Street bank out of Rochester) may slow an express train down to 30 miles an hour, and a really formidable bank such as the Shap (1 in 75) or Beattock (1 in 69) gradients on the West Coast main line down to 25 miles an hour. The Diesel unit, like its cousin the motor car, hardly worries about signal checks and laughs at railway gradients. Owing to its acceleration it reaches its maximum speed in seconds where the steam locomotive requires minutes. Consequently, although its maximum speed is not much higher than that of the steam locomotive, it can easily maintain an average speed far beyond the latter's normal capabilities. It is not, therefore, surprising, to learn that the Flying Hamburger has the fastest train schedule in the world (though the G.W.R. record of June 6, 1932, referred to above, still appears to be unbeaten). This Diesel express is booked daily to cover the 178.1 miles from Berlin to Hamburg in 138 minutes, at an average speed of 77.4 miles an hour, and the return journey from Hamburg to Berlin in 140 minutes, at 76.3 miles an hour. A more powerful unit is to be placed in this service, having engines of 1,200 h.p. designed for a maximum speed of 106 miles an hour. Such has been the success of the Flying Hamburger that further high-speed Diesel railcars are to be put into service in Germany. But perhaps the most important advantage of

these railcars is that they are far cheaper to operate than steam trains. The gradual supersession, therefore, of existing rolling-stock by railcars would appear to promise working economies of a most gratifying nature.

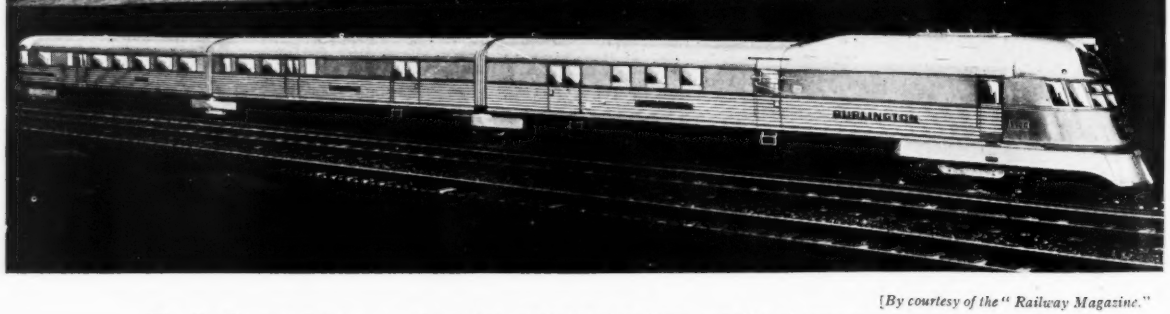
It follows from the success of the German railcars, which are now being copied all over the world, that the heavy express train, lavishly equipped with restaurant, kitchen, and sleeping cars, as well as spacious luggage vans, is about to become out of date. Equally obsolescent is the electric train drawing its motive power from a third or fourth rail or from an overhead wire. The chief advantage of the ordinary electric train over its steam-hauled rival lies in its acceleration, which makes it so useful on stopping suburban services ; this quality alone has been held to outweigh the enormous cost of equipping a railway line for electric traction. The Diesel unit, however, can beat even the electric train in the matter of acceleration, and it requires no expensive track alterations ; in fact, it can run on any track suitable for a steam locomotive. Electric tramways are being scrapped all over the country ; electric railways will not be long in following them into oblivion. This may sound rather strange in view of the recent activities of the Southern Railway ; but Diesel straws show which way the wind is blowing.

It may take some time to convince the public (which after all pays the fares) that famous trains like the Flying Scotsman, Royal Scot, and the electric Brighton Belle (to say nothing of equally well-known Continental and American expresses) have become unnecessary luxuries. What is needed is to educate the public to give up its preference for compartment carriages, to travel light, and to eat lightly whilst travelling. At present it likes (and grouses at) heavy restaurant car meals only because the supply has created the demand. Bygone generations were satisfied with a sandwich and a drink of tea or beer. The present generation will soon become accustomed to the buffet whilst travelling by train. The traveller of the future will have to restrict himself to one small suitcase, and he will no longer be able to secure that delight of every Englishman, a carriage to himself.

It can be objected that the Diesel unit may be adequate for some services, but that very many trains carry far more than 102 passengers. The answer to this is that there is no technical objection to coupling together two or more of these units, as has already been done in the Netherlands. The new Dutch railcars comprise units of three articulated cars, weighing 80 tons in all, driven by Diesel engines of 820 h.p., and designed for a maximum speed of 140 kilometres (87 miles) an hour. Each unit seats 48 second-class and 112 third-class passengers. Two units are frequently coupled together. Trains of railcars can be made as long as traffic conditions demand. The Union Pacific RR. of America has shown the way by building comparatively long Diesel trains.

The U.S.A. also have a remarkable example of the modern railcar in the Burlington Zephyr, a unit owned by the Chicago, Burlington, and Quincy RR. This is an articulated unit of three coaches, driven by an eight-cylinder two-stroke Diesel engine of 600 h.p., and weighing 87½ tons. There are seats for 72 passengers. This railcar recently set up a world's record for long-distance running by covering the 1,015 miles between Omaha and Chicago in 13 hours 5 minutes, at an average speed of 77.6 miles an hour, with a maximum of 112.5 miles an hour.

France possesses some interesting railcars. A Bugatti railcar consisting of a single car 76 ft. long and weighing but 23 tons, driven by four eight-cylinder Bugatti engines totalling 800 h.p., and designed for a maximum speed of 150 kilometres (93.2 miles) an hour, runs daily in summer between Paris and Deauville, 137.5 miles, in 2 hours, at 68.7 miles an hour. Its maximum accommodation is 60 passengers. Not long ago it ran on a



[*By courtesy of the "Railway Magazine."*

The Burlington Zephyr, an American articulated railcar, capable of over 112 miles per hour.

[*By courtesy of the Locomotive Publishing Co.*

The Deauville Express railcar, with four Bugatti engines, likewise capable of a speed of 112 *miles per hour.*

special trip from Paris to Cherbourg, covering the 234 miles in 3 hours 8 minutes, at an average speed of 74.6 and with a maximum speed of nearly 112 miles an hour. The P.L.M. have a Bugatti railcar of two articulated coaches, weighing 61 tons and seating 123 passengers, running between Paris and Lyons, 318.2 miles, in 4 hours 40 minutes, including two stops, at 68.1 miles an hour. There is another fast railcar service between Paris and Vichy, and yet another (on the Nord) between Paris and Tourcoing. Diesel-electric units have appeared also in Denmark. Each of these consists of three cars totalling 118 tons, driven by engines of 1,100 h.p., and seating 156 passengers.

In Great Britain railcars of many descriptions have been built, driven by oil or by steam, ever since the days of the leisurely rail motor car found on so many country branch-lines a few years ago, but rather less popular to-day. No very fast railcars have as yet been put into service. The L.N.E.R. have a few express railcars working in the North-Eastern area, and the L.M.S. have experimented with various types, including a " Ro-Railer " which can run equally well on road and on rail, and a more conventional Diesel-engined car which ran daily between Euston and Birmingham during the British Industries Fair in 1932 at a speed somewhat below that of the standard two-hour steam-hauled expresses. The most important British examples are the G.W.R. railcars operating between Birmingham and Cardiff. Each car is 62 ft. long, weighs 25 tons, and is driven by two 130 h.p. Diesel engines, designed for a maximum speed of 75-80 miles an hour. There are seats for 40 passengers.

It will have been noticed that in every one of the instances given above weight has been cut down to a minimum and the greatest possible passenger accommodation consistent with reasonable comfort has been provided. In some cases the total weight of a railcar, including its motive power, is actually less than that of a modern corridor coach. This achievement shows that locomotive engineers have at last become aware of the unnecessary heaviness of modern steam-hauled express trains, with the necessary corollary of immensely powerful locomotives to cope with the overweight. Having realised that dead weight means dead loss, they are equally unlikely to favour much longer any scheme of electrification, since the modern electric train, including the motors, etc., is nearly as heavy as its steam-hauled rival.* In view of the fact that Continental and American railways have brought the weight of their expresses to the point of absurdity, it is not surprising that the first and most striking evidences of a change of heart should have emanated from Germany and the U.S.A.

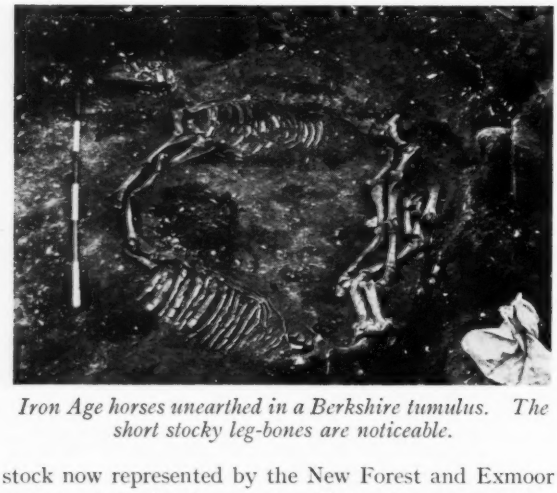
A Diesel-engined railcar, capable of average speeds (start-to-stop) of close on 80 miles an hour, and possessed of accelerative powers sufficient to deal with heavy gradients and unforeseen delays, is capable of challenging the aeroplane in point of speed for distances up to 250 miles. Owing to its powers of acceleration, it can work a stopping train so expeditiously that, properly employed, it ought to be able to divert a good deal of local motor bus and coach traffic back to the railways. Owing to its cheapness of operation, its extended use ought to result in lower fares and better dividends. When the general public finds that the railways are providing local services much faster and no dearer than motor bus companies, and long-distance services much cheaper and little slower than air companies, it will begin to return wholeheartedly to the railway.

*The latest six-coach S.R. Brighton express sets tare no less than 266 tons apiece. A modern steam-driven train of six corridor coaches, including a dining car and the locomotive, weighs about 330 tons.

Ancient Horses.

In October, 1931, Professor Sir Flinders Petrie recorded, in the pages of *Discovery*, the burial of a horse dating from not later than 2250 B.C. The horse was apparently introduced into the Mediterranean area from Central Asia by the invading Hyksos and, unknown before, it spread rapidly throughout Europe. The date of its introduction into Britain is not certain, but the Newbury Field Club, in some recent work carried out under a scheme for relieving unemployment, has thrown interesting light on the method of horse-burial, and the manner of animal which was buried, in the Iron Age in Britain.

In the excavation of a tumulus on the Berkshire Downs, near East Hendred, the chief find was that of the skeletons of two horses, which had been buried with their legs intertwined. One of the skeletons was found in a remarkably good state of preservation, the head, body and legs being almost complete. In the case of the other skeleton the head was missing; rabbits, some of the archæologist's bitterest enemies in England, had burrowed into the tumulus and scattered the head-bones. The animals whose skeletons were found were of a stumpy build, as the heads were large but the necks and legs were short. The teeth were found to be as large as those of the ordinary cart-horse, but the cannon bones in the legs were only $8\frac{1}{8}$ inches long instead of 11 inches, as in the modern full-sized horse. The skeletons found are of the type of horses bred during the Iron Age, a



Iron Age horses unearthed in a Berkshire tumulus. The short stocky leg-bones are noticeable.

stock now represented by the New Forest and Exmoor ponies. Actually it was not until the 18th century that the present type of English racehorse came into being, with the introduction of Arab blood. A glance at Charles I's charger at Charing Cross, which experts agree to be a good representation, will quickly show the

A Hyksos horse-burial, revealing a skeleton similar to those of 2,000 years later.

difference between the steeds of the 17th and of the 20th centuries.

The method of burial was apparently similar to that of the "chariot burials," examples of which have been found in Yorkshire. There, however, the chariot and harness were found together with the horses, but in the present instance no remains of harness have been found. The owner of the horses was likewise missing, but the discovery in the same grave of two brooches of La Tène III period would place the date of the burial at about 200 B.C.

Our two illustrations offer an interesting comparison. Though, perhaps 2,000 years separate the life of the Asiatic horse and the British horses, the type of skeleton has changed very little. We are indebted to Mr. C. F. B. Marshall, who has latterly been in charge of the excavations, for the East Hendred photograph and for details as to the discoveries on the site.

Essex Place-Names.

The English Place-Name Society, under the direction of Dr. Allen Mawer, is now devoting its attention to a volume on Essex, a county particularly rich in names of fields and small-holdings. In approaching East Anglia, the problem of unexpected pronunciations will be met with in full force, though there is a tendency nowadays towards pronouncing according to orthography. All the same, a party of Norfolk yokels recently derived much amusement from the efforts of a distinguished member of the League of Nations Union to enquire the way to Costessey—which is *not* pronounced as spelt.

The City of the Sun-Disk.

By Our Special Correspondent.

The exhibition of the recent work of the Egypt Exploration Society, which has just closed, displayed the remarkable results of last season's work at Tell el-Amarna. Many interesting discoveries were made concerning the "heretic city" and the excavators approach their coming winter's work with the keenest anticipations of further success.

At the death of Amenhotep III, the mighty hunter, somewhat before 1380 B.C., dominion over the Egyptian Empire devolved upon his son, who had likewise been given the name Amenhotep. The new king was eccentric, to say the least of it, and exhibited marked peculiarities, both mental and physical. For the old Theban gods he attempted to substitute the worship of the Aten, or sun-disk; he changed his name to Akhenaten; and removed the capital from Thebes to an entirely new site.

It is this site, the city of Akhetaten, lying about half way between Luxor and Cairo on the east bank of the Nile, that the Egypt Exploration Society's expedition, led by Mr. J. D. S. Pendlebury, is engaged in excavating; already they have brought to light many significant facts as to the character of its founder; and there is every reason to believe that even more important discoveries await them.

Modern interest in the site was first aroused by the discovery of the official correspondence of the period—the Amarna Letters. These clay tablets, inscribed in cuneiform, give a vivid picture of the downfall of the Egyptian Empire in Syria, the desperate appeals of the vassal kings for help against the Hittites and the deadly apathy of the Egyptian court.

In 1891 Petrie excavated in the Official Quarters and also cleared a number of private houses. In 1902-05 Davies was engaged in the copying of the scenes from the tombs of the nobles, on behalf of the Egypt Exploration Society. From 1907 until the war the Deutsche Orient Gesellschaft began the systematic clearance of the South City, during the course of which they made the discovery of the sculptor's house with its wonderful series of portrait sculptures, including the famous head of Nefertiti. After the war the concession fell to the Egypt Exploration Society which has continued the excavations ever since.

Before describing the results of the excavations, some idea may be given of the difficulties involved. The Egyptian fellahin are not noted for calmness of temperament, and the Beni-Amrân, the tribe from whom the site derives its modern name, are notorious for their hot-headedness and general destructiveness. The stucco floor of the Palace, which Petrie discovered, was smashed to pieces some twenty years ago, apparently to satisfy some private grudge; and a similar wave of sabotage is affecting the tribesmen to-day. Moreover, there is the continued difficulty of lack of funds. The Egyptian excavator is not, as some people are apt to think, a millionaire financed by millionaires.; he is just as much hampered by financial stringency as any other research student. All subscriptions, however small, are welcome; one shilling a day provides an extra workman, ninepence a day a boy porter. Sums sent for this expedition to the Egypt Exploration Society, 2, Hinde Street, London, W.1, should be earmarked "Tell el-Amarna."

Incidentally, Tell el-Amarna is not the correct name of the site, but a sort of excavators' slang which has been

Wine-jar sealings of mud, dyed blue and inscribed "Wine, very, very good" within the royal cartouche.

generally adopted. There is no *tell*, or great mound, in existence here; and the correct name should be et-Till Beni-Amrân.

The recent excavations have shown that the city of Akhetaten was built very rapidly, about 1380 B.C.; a good deal of jerrybuilding has been detected; and several sculptors' "trial pieces" go to show that unskilled labour was hastily drafted in to hurry on the completion. The buildings under observation were the Great Temple, the Records Office, and the Police Barracks. The Temple was razed literally to the ground by one of Akhenaten's successors, Horemheb, and obliterated beneath a layer of cement. This drastic action on the part of the orthodox king has at all events preserved the

The paved armoury of the police-barracks showing the recesses for the storage of arms.

foundation-lines more or less intact, and the way in which the reconstructed plan tallies with the tomb-pictures of the Temple is most striking. A fine sandstone head, representing probably Smenkhara, co-regent towards the end of Akhenaten's reign, was among the few objects found on this site.

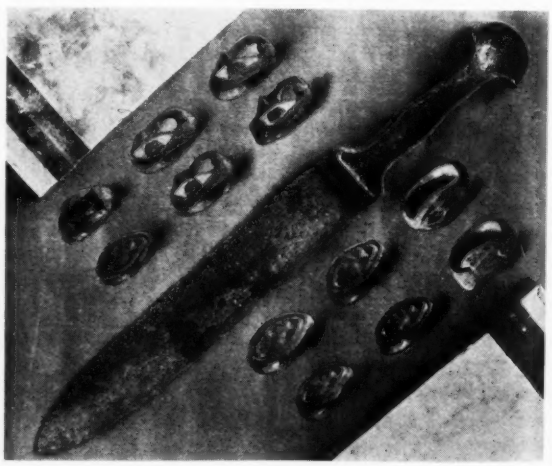
The block of buildings immediately to the east of the Royal Estate was the scene of the discovery of the famous "Amarna Letters." Several more fragments were found during the course of digging the Records Office itself, while another was found in one of the clerk's houses to the south. The apologetic note of a dispatch from a departed Egyptian general gives a human touch to these long-past events. The clerk's houses are, like the workmen's cottages, all built on a single plan: an entrance lobby, a main living room, and two cubby holes for bedroom and kitchen. To the east again lies the University, in which were found a number of sherds inscribed with the names of Royal Scribes, i.e., the lecturers and professors, and one with a fragment of a Sumerian-Akkadian dictionary.

On the extreme eastern edge of the city, bordering the desert, lie the barracks. for the mounted military police. Their position is due to the fact that the open desert afforded a clear run for the chariots to a point opposite any scene of disturbance in the city, thus obviating the necessity for traversing the narrow streets. The west side of the building is taken up with the men's quarters and the commandant's house. On the west side also is the Armoury with recesses for use as arm-racks. In the centre is a big parade ground with a well in the middle and tethering stones and mangers all round for the flying squad to be kept in perpetual readiness. To the east lie the long cobbled stables. Some fragments of the leather collars of the police uniforms were among the few soft objects which had survived the ravages of the desert termites.

Among the movable finds are many characteristic objects. Portions of two pottery vessels were found with the inscription "mouse's flesh"; whether this was used as a food or a magical drug (as until the last century in England) is a mystery. In the police commandant's house were several wine-jars sealed with mud. These sealings are exceptional in being painted blue and having the inscription "Wine: very, very good" surrounded by a royal cartouche. Either the king or his commandant had a connoisseur's palate. The accentuation of the physical peculiarities of the king, notably his extreme leanness, in some of the drawings, has been considered by some as an indication of a new school of art. Much more probably these are malicious caricatures of an unpopular monarch by some orthodox workman pressed into the heretical service of the Aten; in the Cairo Museum, indeed, Akhenaten is actually caricatured in the form of a monkey.

Artistically attractive are the miniature faience rings, found in a hoard along with a gold ring, and glazed in different colours to imitate precious stones; and a bronze dagger with an elegantly shaped handle hollowed to receive inlays of lapis lazuli or other material. Notable also are a fragmentary but expressive figurine of a monkey; bronze bulls and signet rings; and a great Scarab of Amenhotep III recording the number of fierce lions he killed in the chase. It is notable that, in his hatred of the god Amen, Akhenaten has erased his father's personal name.

The city of Akhetaten was short-lived. On the death of Akhenaten about 1358 B.C., while his younger brother



The bronze dagger has lost the inlay of its handle. The miniature faience rings are coloured in imitation of precious stones.

Tutankhamen was still a boy, the court moved back to the old capital, Thebes. Hatred of Akhenaten, who, dreaming of his new god, had allowed the Empire to go to ruin, burst out; his name was erased, his temple razed to the ground, and the site lies deserted to this day save for two Arab villages.

The work done during the past season was made possible by the generosity of the Brooklyn Museum, who supported our work on the advice of Professor Capart of Brussels, and of Mrs. Hubbard of New York, and other friends.

Mr. Pendlebury reports that he expects to start a new season's work at the beginning of December. The Great Palace will be re-explored, when every endeavour will be made to discover to what extent the ground plan agrees with the pictorial representations. This is likely to be more difficult than in the case of the Temple, as the tomb-pictures of the Palace are largely conventionalised. New sites to be excavated include the buildings south of the Police Barracks and the Temple Magazines; the amount completed will depend on the financial support available.

Vanilla at Home.

The spice vanilla is derived from the dried and cured pods of *Vanilla planifolia*, a climbing orchid found in the forests of the Amazon. The stem of the plant is succulent and grows to a great length: it requires a support to cling to and in nature it is found encircling the trunks of trees. The joints on the stem are near together and one fleshy leaf and one tendril for climbing are found at each joint. The flowers are produced from the axils of the leaves and the pods following the flowers are kidney-bean shaped, and from 9 to 12 inches long. When dried, they are the vanilla pods of commerce.

A vanilla vine in its native haunts.

The vanilla creeper may be seen growing wild in the Amazonian forests, or cultivated in the Zoological Gardens at Paiá, both of which are now easily accessible to British travellers, thanks to the Amazon cruises of the Booth Line, both in summer and winter.

Correspondence.

SCIENCE AND RELIGION.

To the Editor of DISCOVERY.

Sir,

Man does not believe in God because He is a necessary hypothesis, nor are his prayers habitually of the crude kind suggested by Professor Huxley. The "Lord's Prayer" may be repeated by the most learned scientist or the most ignorant peasant. Science is not antagonistic to religion, but, as Canon Streeter says, she "is the great cleanser of human thought which makes impossible any religion but the highest."

As the human race progresses in knowledge, elementary beliefs gradually give way to truer notions of the mighty Universe: "the larger grows the sphere of knowledge, the greater becomes the area of contact with the unknown," but this makes man's idea of God greater not less.

Man believes in God because he is a "praying animal." Of the many definitions of religion, Baron von Hügel's "Religion is adoration" is perhaps the best. "Ah gentle God, if Thou art so lovely in Thy creatures, how exceedingly beautiful and ravishing Thou must be in Thyself!" says Suso, or again a Sufi mystic: "If I worship Thee from fear of Hell, burn me in Hell, and if I worship Thee for hope of Heaven, exclude me therefrom; but if I worship Thee for Thine own sake, withhold not from me Thine eternal beauty." One could multiply such quotations did space permit.

With regard to Professor Huxley's questionnaire; we may answer many of the questions as he does, but without drawing the same conclusions. Some of the questions require a whole volume in reply. The crude view of prayer implied would be dispelled by reading the learned and beautiful essay "Faith, prayer and the world's order" which appeared in *Concerning Prayer*. Its author Arthur Charlewood Turner was killed in the War and the essay has been reprinted separately by Macmillan and Co. Those who think that if the Devil fades away, God must do likewise, would be well advised to read Tennant's *Concept of Sin*.

Professor Huxley's views must appear out of date to those who have followed recent pronouncements of both biologists and mathematical physicists, for on the plane of reason alone the hypothesis of a reasoning and conscious Creator is gaining ground. It is only necessary to attend the British Association, or to watch the scientific periodicals of a popular nature to become convinced that belief in God, is at the present time, increasing among Scientists.

Yours faithfully,

MARY D. WALLER, B.Sc., F.Inst.P.

Physics Department,
London (R.F.H.) School of Medicine for Women.
21st September, 1934.

To the Editor of DISCOVERY.

Sir,

In your September issue you ask for your readers' views on Professor Huxley's curious questionnaire. I call it curious because the "philosophy" behind it is so essentially that of the rather crude 20th century, or even the cruder 19th. Few of the questions can be answered by a plain yes or no. Some can hardly be answered at all because so naively put. All depend on definitions which should be agreed upon beforehand.

In question 1, for instance, what is meant by "natural"?

When men catch fish do they interfere with the natural course of events? In a sense they do; in a wider sense they do not, since it is natural for them to do it. They merely introduce a higher principle—the human will—into Nature as such, but there is no suspension of natural law. Then what are "ordinary scientific principles"? Those which we know, or think we know, today? But these will almost certainly be changed tomorrow. Radioactivity was inexplicable (and therefore presumably a miracle) by the ordinary scientific principles of fifty years ago. But if Professor Huxley means not so much the changing generalisations of our empirical knowledge but rather the changeless principles of philosophy and thought no miracle contravenes these.

The wording of this whole question suggests that nature is something existing outside and apart from God. But the infinity of God is His (or Its) primary postulate, without which the idea of divinity is only a barbarous notion, and how can anything be outside the Infinite?

I cannot encroach on your space to refer specifically to the remaining questions. The above applies in general to most of them.

Professor Huxley mentions educated people, especially the scientifically trained. But who is educated? Who is trained really scientifically? (I might for example include myself under both heads in the colloquial sense: in the real sense I am neither.)

I would concede him the Devil, if by that he means a real principle of evil, for that which is the negation of a positive reality (the good) cannot in itself be real; it has merely a negative relation to the good—as cold to heat. But goodness *is* God in one of His primal aspects.

Definitions are a *sine qua non*. What is this God we are discussing?

The Professor says God is fading away as a result of Science. That is probably true of *what he means* by God—who is at best (as he says) a mere hypothesis.

The God of the Theist, however, is the ultimately real. Hypotheses frequently fade, but it were strange indeed if knowledge should disprove reality.

Yours faithfully,
FRANCIS H. A. ENGLEHEART.

Dedham,
Colchester.
30th September, 1934.

To the Editor of DISCOVERY.

Sir,

I am a reader of *Discovery* from No. 1 to the present number, in which Professor Huxley issues his challenge. It occurs to me that you might be willing to allow me to direct your readers to a principle stated by St. Paul in his First Epistle to the Corinthians (II, 13 and 14; Moffatt's Translation), as the words to me explain the difficulty in question.

"We interpret what is spiritual in spiritual language. The unspiritual man rejects these truths of the Spirit of God; to him they are sheer folly, he cannot understand them. And the reason is, they must be read with the spiritual eye."

Yours faithfully,
C. H. B.

Beckenham, Kent.
September, 1934.

MATHEMATICS THE BIOLOGICAL SCIENCES

To the Editor of DISCOVERY.

Sir,

In a letter published in the October number of *Discovery* Mr. T. W. MacAlpine stresses the importance of the mathematical analysis of biological data, but appears to be unaware that in this country the mathematical treatment of biological problems has had a long and fruitful history. It must now be 40 years since Professor K. Pearson contributed, from the department from which I now write, his mathematical contributions to the study of evolution, an extensive series of memoirs, published in the Philosophical Transactions of the Royal Society.

Mr. MacAlpine says "Were collaboration of the mathematician and biologist undertaken, it would bring powerful mathematical aid to the latter and might also contribute to the development of mathematics itself." This is expressed as a forecast, and as such it is correct and penetrating. Why not express it as a fact? Biological research workers in every continent in the world are now using tests of significance and other means to the interpretation of biological observations based on mathematical advances made entirely within the last 20 years, and which are still apparently unknown in many centres of mathematical teaching. There is, therefore, no more doubt as to the utility of these researches in favouring clarity of thought and an actively critical attitude towards research problems, for this advantage is being actively exploited. The other advantage which Mr. MacAlpine foresees is at present rather potential than actual. The classical corpus of mathematical material generally taught is almost exclusively devoted to the attainment of exactitude in deductive reasoning. That other half of human reasoning, used in drawing inferences from the particular to the general, the bottle neck through which every new observational fact must pass before it can be added to the body of human knowledge, has been neglected by the greater number of mathematicians, and has only been cultivated by the smaller groups interested either in the extension of mathematical logic or in the practical and technical details of experimentation.

During recent years, these two groups have, however, made sufficient progress as to resolve the classical paradoxes and anomalies of the subject, and to have demonstrated the essential fact that rigorously exact mathematical inferences are possible in inductive as well as in deductive reasoning. Thus a new half of mathematics has been opened up.

Perhaps I may criticise one sentence of Mr. MacAlpine's letter: "One does find, it is true, a treatment of a metrical and statistical character in modern writings on biological science, but rarely does it appear that the writer has a working acquaintance with the more penetrating methods of mathematical analysis." If this means that biologists sometimes apply erroneous methods of interpretation would it not be simpler to say so, for we should then know that all that was wanted was to discover the appropriate rigorous and comprehensive method? If, however, it means that deductive mathematics, as so far developed, contains a repertoire of methods, the potentialities of which have not been perceived by those who are interested in inductive problems, then we are under the painful necessity of suggesting that the boot is on the wrong leg; that it is in statistical concepts that modern physics, for example, is discovering the more penetrating analysis of which until recently it stood in need.

Yours faithfully,
R. A. FISHER.

Galton Laboratory,
University College, London.
3rd October, 1934.

Discoveries in Italian Art.

The art of Italy, whether classical, mediaeval, or renaissance, still holds many problems for the investigator. Here we give details of two remarkable recent discoveries. The account of Professor Pozzi's work at Pompeii is summarised from his article in "La Stampa" of Turin. We are indebted to a special foreign correspondent for the sensational information about Michael Angelo's famous statue.

Frescoes that are not Frescoes.

PROFESSOR MICHELE POZZI, whose work as a restorer of ancient paintings is well known, recently made a discovery of great significance regarding the technique of the Pompeian mural paintings. The descriptions of this technique by Vitruvius and Pliny the Elder have hitherto seemed so strange that it has been thought that some error in transcription must have been made by an ignorant copyist; and the general opinion has been that the Pompeian paintings were frescoes in the strict sense of the word, in spite of the fact that Vitruvius's description indicates otherwise.

The photograph of the painting here shown, however, makes it quite clear that where the colours of the paintings have peeled off, a background colour is seen; indicating that the paintings were superimposed on a prepared coloured background and were therefore not true frescoes.

The earliest authority that we have for the statement that the ancients used the fresco method is Vasari, and in this he is contradicted by L. B. Alberti, who asserts that the ancients never painted straight on to the plain unprepared wall.

Professor Pozzi determined to investigate the problem. The materials at his disposal were: a detailed description of the technique; a complete outfit of artist's materials discovered at Pompeii; and the paintings themselves. By the courtesy of the Duce, Professor Pozzi was able to obtain actual fragments of the paintings and subject them to analysis in the laboratory and the result of his investigations has satisfied him that the descriptions of Vitruvius and Pliny were correct. From the artists' materials discovered at Pompeii Professor Pozzi was able to obtain a test-tube full of the mysterious colour *purpurissum*, the actual tincture of the murex used for the Roman purple dye twenty centuries ago. And it was possible to reconstruct samples of the painting, producing the "mirror-like gloss" which was described by classical authors and was unattainable by the fresco painters, even by Luini himself. Moreover of the twenty-one colours listed by Vitruvius, only five (and these the most unimportant) were able to resist lime; therefore it is reasonable to suppose that some method other than fresco was employed in connection with them. The wax-colours used in painting were dyed, according to Pliny, with the same tints as were used for encaustic painting, but were applied direct on to a wall *already prepared* with a coloured distemper surface. This technique is entirely different from that of fresco, in which water-colours are mixed with the plaster that is being applied to the rough wall. At the same time the encaustic method was not essential, as owing to their oiliness the wax distemper colours could be applied direct to the dry prepared surface.

The Pompeian paintings, then, were not fresco-paintings, but were executed by a method apparently the invention by the artists of the Augustan age, showing a distinct advance on the Greek encaustic method; while the art of fresco-painting is seen to be a purely Italian discovery.

A Pompeian "fresco," with the black ground-colour showing through the painting. The black patches have been slightly accentuated in the photograph.

The small head of Julius II stands out beneath the lower lip of "Moses." The profile of Michael Angelo is silhouetted by the shadows on the left of the beard.

Mystery of "Moses"

An Italian art historian, a Roman priest, has found in the strands of the beard of "Moses," the great Renaissance statue by Michael Angelo, the self-portrait of the artist and the portrait of Pope Julius II. A great deal has been written about this statue, which really constitutes a library in itself. Scien-

tists have analysed every detail of this classical work of art, and drawn and photographed it from every angle. It seemed that nothing new could be told about the statue, until Don Giuseppe Parroni, one of the brilliant priest-art-historians of the Vatican, discovered in San Pietro in Vincoli, the church in which the statue of Moses stands, a great secret concerning this work of art.

It was on a misty and rainy day that Don Parroni sat before Moses as was frequently his habit. Anybody who has visited this church can easily understand Don Parroni's action. As he looked at the statue he suddenly felt something. Next minute he stepped nearer to the statue to examine the strands of Moses' beard just under the curve of the mouth. Then it was that he could distinguish the exact contours of an interesting male head. Immediately afterwards he made out the contours of another and far bigger head of Michael Angelo himself, also in the strands of the beard. It seemed to be a shadowy drawing of the profile of the great Renaissance genius.

A Shadowy Profile.

Don Parroni, as he described it later, did not know whether his nerves had played him a trick, or whether what he had seen had indeed been reality. Next morning he again looked at the statue. At first he did not notice anything. Then he tried to place himself at the exact spot in the church from which he had observed the mystery on the previous day. Almost at once he discovered the clear outline of a small male head and to the left of this little head the shadowy contours of the bearded face of Michael Angelo. On the third day he had a number of photographs made of the statue. The developed pictures clearly showed the bearded face of a man and a queer shadowy profile of the hooked nose of Michael Angelo.

It was soon proved that the smaller portrait depicted Pope Julius II. It should here be pointed out that Michael Angelo had been commissioned to make a statue of Moses as part of the tomb of Julius II. Art historians noted the great resemblance of this small hidden portrait to the known portraits of the famous Pope and stated that it undoubtedly portrayed the same features. But Michael Angelo's shadowy profile caused great dispute. The characteristic hooked nose and beard of Michael Angelo could be seen only from a certain position, and they were clearest at sunset, when the shadows are deeper. But from even half a pace away from the exact spot they could not be distinguished. Why did Michael Angelo play this queer trick in his great artistic creation? Throughout four centuries has the secret of the artist's playful idea remained hidden, and now it has been discovered only by a mere accident.

Radio Developments.

By Our Special Correspondent.

Our correspondent contributes further details on the less familiar aspects of radio development, which have a special interest of their own.

Permanent Magnets for Loud-speakers. "Alni" alloy magnets are produced by Swift Levick and Sons, Ltd. They are examples of the modern research and care which go to produce an entirely satisfactory material for use in modern moving coil speakers. These permanent magnets are made by casting and not by forging, as the material of the magnet is too brittle.

Portable Power for Public Address. A series of very neat and compact machines is manufactured by the Electro-Dynamic Construction Co., Ltd. Their products include D.C. to A.C. rotary converters, rotary transformers, constant current charging dynamos and an entirely portable petrol-driven alternator. The last mentioned device consists of a 50 c.c. two-stroke petrol engine, connected by belt-drive to a 200 watt alternator. Various types of these petrol sets can be made up to order. A hand starter is provided on the engine, or it may be started from a car battery.

Aids for the Deaf. Messrs. Ardente have a range of refined apparatus for enabling comparatively deaf persons to hear clearly. The choice of apparatus is necessarily dependent on the degree of deafness, but all the models, while differing in purpose, have effective tone and volume controls fitted. "Fardente," size overall 7 in. by 7 in. by 3 in., is a two-valve amplifier suitable for use in an ordinary sized room. Weight 5 lb. "Publique," size overall 12 in. by 9 in. by 4 in., will operate in a large room, e.g., at board meetings.

The combined radio-gramophone and deaf-aid is a most interesting and ambitious device. It includes a gramophone for records up to 10 in. diameter, crystal pickup, three midget valves, and a speech microphone. The radio portion operates on the medium and long wave-lengths and requires only a very short aerial.

Cathode Ray Oscillograph. Messrs. Ediswan have on the market vacuum tubes for use in television. The elongated envelopes have one end flattened and expanded and coated with synthetic zinc silicate for use as a fluorescent screen. Two classes of the tubes are made, hard and soft or gas-focused tubes. The hard tube is the more important: the plates around the filament have a potential of minus 50 to 100 volts, the first anode has plus 600 volts, and the second about 1,800 volts.

Picture or visual impulses produced by a cinematograph or epidiascope can be resolved by means of these cathode ray tubes, the light being the green of fluorescing zinc silicate.

China's Airways.

By E. H. Anstice.

Much ink and much talk is spent by theorists on China's economic problems. In the meantime the country is progressing in its own leisurely way. The air services described below are an effective means of internal communication, but the question of trans-Asiatic air routes opens up a wider problem.

THE aeroplane and its possibilities have undoubtedly taken great hold on the Chinese imagination. The country's leaders are nothing if not air-minded, as is shown by their constant recourse to this mode of travel, and the fact that almost every one of them maintains his own private plane, employs his own foreign pilot. It is not surprising, therefore, to find that since the present government came into power it has devoted considerable attention to aviation, not only in the form of creating an effective air force but also in encouraging the development of commercial airways. These latter are part and parcel of the general scheme for improving China's means of communication in which she is so lamentably deficient. She has, for example, only one mile of railway per 700 square miles of area as compared with Great Britain's one mile per four-and-three-quarter square miles, and again, only one mile of road per 240 square miles, as compared to Great Britain's one mile per half square mile. Until five years ago she had to all intents and purposes no airways at all. Some kind of air service had been very intermittently maintained between Peiping and Peitaho and Peiping and Tsinan, but that was all.

A monoplane of the Shanghai-Peiping service (C.N.A.C.) at the Lunghwa depot.

Since that date, however, there has been considerable progress. In 1929 a regular service was started by the Ministry of Communications between Shanghai and Nanking, while China Airways, an American company, maintained one on a contract basis for the government-owned China National Aviation Corporation between Shanghai and Hankow. In July, 1930, these two services were amalgamated on the reconstruction of the China National Aviation Corporation as the result of an agreement between the Ministry of Communications and China Airways, the former putting up 55 per cent. and the latter 45 per cent. of the authorised capital. Earlier in the same year, in February, a Sino-German air-mail contract had been signed, and the Eurasia Corporation formed to implement it. Here the government put up two-thirds of the capital and the German Luft-Hansa one-third. These two companies at present divide China's commercial aviation between them. They are complementary to each other rather than rivals, the C. N. A. C. being more concerned with opening up routes in China, the Eurasia Corporation with establishing direct communication between China and Europe. The former, therefore, operates chiefly up the Yangtse River and along the coast, serving the more populous and developed areas, where there is naturally the greater demand for air transport facilities, while the latter devotes practically the whole of its energies to establishing a safe and practicable service to the North-West and thence to the Soviet border.

Both companies depend at the moment on air-mail contracts for the majority of their business. Statistics of passengers and freight carried are, like most statistics in China, hard to come by and, when obtained, very approximate. It is with this qualification that the following figures are given: *China National Aviation Corporation:* Passengers carried, 1930-1933, 11,500; mail matter and freight carried, 344,000 lbs.; miles flown, 1,843,000. *Eurasia Aviation Corporation:* Since opening to December, 1933: Passengers carried, 1,600; mail matter and freight carried, 44,000 lbs.; miles

flown, 345,015. The C.N.A.C., in fact, as is only to be expected, does by far the more business. Not only does it serve the more prosperous areas, but it has more planes and better equipment. Of the former it has about twenty, mostly amphibians, from America. Its main depot and repair station is at Lunghwa near Shanghai, while mechanics are stationed also at Hankow and Chunking. Landing-fields and depots for petrol and spare parts are easily organised along its routes, since these follow the river, a railway, or the coast, over districts already opened up. Its flying personnel is almost entirely foreign, though Chinese co-pilots are gradually being trained.

The Eurasia Corporation also relies on foreign pilots to operate its dozen or so Junker machines. Its depot is at Hungjao, Shanghai. As compared with the C.N.A.C. the greater part of the country it flies over is practically undeveloped, river, road, and rail communication being practically non-existent. The further north-west one proceeds from Nanking the more difficult the country becomes. In many places machines have to climb to 13,000 feet and more, and even then in places to spiral along the mountain sides. There is little hope of escaping damage, if not death, if forced down in such a country while there are also political and racial troubles to contend with. Sinkiang, for example, has been in a very disturbed, if not rebellious condition for months, which has tended to complicate considerably the efforts of a semi-official corporation. Further north the people of Outer Mongolia are by no means to be relied upon for a friendly reception. One pilot and mechanic who had to make a forced landing there were held prisoners for months. There is, too, the great problem of maintaining depots with adequate supplies of petrol, spare parts, and other necessaries, in an area where everything has to be carried long distances overland from one of the two railheads, Sian and Paotao, by truck, bullock-cart, or camel, all an easy mark for bandits.

The Sian Depot of the Eurasia Corporation.

A Junker plane of the Eurasia Corporation.

The bringing of outlying provinces into closer contact with the business centres of the country, is the chief service that the aeroplane can render China. The C.N.A.C. has already shown Shanghai business men the convenience of getting to the North in one day instead of three, to the South in one day instead of four.

And the Eurasia Corporation holds out the prospect of an even greater saving, one that appeals especially to the foreign imagination: Shanghai to London in well under a week—could there be anything more alluring to the Far-Eastern exile?

The International Physics Conference.

By Dr. Lotte Sperling

FOLLOWING an invitation of the Royal Society, the most distinguished physicists of the world were present in London in the first week of October at an International Conference to discuss the most pressing problems of nuclear physics. Thanks to the work of Lord Rutherford and his collaborators we have amassed an ample fund of knowledge about radioactive substances and about atomic disintegration, which has given an insight into the properties of the atomic nuclei. But until quite recently it had been impossible to account for radioactivity from a theoretical point of view. Though Bohr's atom-model could be applied to every phenomenon concerned with electrons rotating round the nucleus, it supplied no explanation of the spontaneous or artificial disintegration of the nucleus itself. It was not until the development of wave-mechanics that the theorists were able to deal with these difficulties. The first to succeed in explaining the radioactive disintegration of atoms, theoretically, was Professor Gamow, a young Russian physicist. By the aid of wave-mechanics he pointed out the reason why it is only in

certain atoms that the alpha-particles can leave the very strong electric field of the nucleus. Moreover, the properties of the alpha-particles, which had been well-known empirically, could be logically deduced from his theory. Gamow contributed to the conference a paper on the general stability problems of atomic nuclei. It is assumed to-day that the nucleus consists of protons and neutrons, both with approximately the same mass, the first being positively charged, the second having no charge at all. The proton is nothing but a hydrogen nucleus, and alpha-particles are now considered as being built up from two protons and two neutrons. As we ascend the scale of the periodic system of elements the number of these particles inside the nucleus increases. If we assume certain hypotheses on the binding forces between a neutron and a proton, we can compute the energy which holds the nucleus together. It follows from these assumptions that spontaneous proton-radioactivity cannot occur in elements whose atomic number is below 200—the highest atomic number hitherto known being 92—but that the breaking-up of a nucleus by emitting alpha-particles is feasible for nuclei of much smaller atomic numbers. On the other hand this theory contains postulates contradictory to experience. It predicts, for instance, a spontaneous radioactivity of beryllium which has not been confirmed by experiment. In order to meet these difficulties Gamow has put forward the suggestion that, in addition to the proton and neutron, there exists a negative proton in the nucleus. Thus he gets a stable beryllium nucleus and can explain other ambiguities occurring in the disintegration of certain radioactive substances. Still, no experimentalist has hitherto found negative protons, while neutrons and protons can be ejected from elements by bombarding them with particles of high energy. But there is hope that these negative protons may be now detected, for, as Lord Rutherford remarked, physicists are very clever at finding things when they are told to look for them.

The Elusive Neutrino

Gamow's theory accounts for alpha-ray-radioactivity but not for beta-ray-radioactivity or emission of electrons. For many years the behaviour of these electrons has been a great problem for physicists concerned with atomic theory. Professor Fermi in Rome has tried to overcome these difficulties by assuming that beta-ray-radioactivity is always accompanied by the emission of neutrinos. These neutrinos are hypothetical particles of approximately the same mass as the electron and have no electric charge at all. Their existence together with that of the negative proton would fill a gap and restore the symmetry of Nature, for now we know two particles of great mass with a positive electric charge and without charge respectively—the proton and the neutron—and two particles of small mass and with a positive and negative charge respectively—the positron and the electron.

In the Curie Tradition

Among the most important contributions to the discussion was the paper of M. and Mme. Joliot, the son-in-law and daughter of Mme. Curie. They discovered during the last year that if certain light elements are bombarded with particles of great velocity—for instance, with alpha-particles produced by radioactive substances—they are transformed into hitherto unknown forms which send out positive or negative electrons. The emission of electrons is continued after the source of radiation has been removed. In other words, these elements behave under the influence of the bombardment exactly like radioactive substances, the only difference being that their disintegration is not know in Nature but has to be artificially produced. The reason is that the lifetime of these new radioactive substances is very short.

Among those who made a systematic investigation of this phenomenon was Professor Fermi. He turned to heavy elements and found that he could induce in them artificial radioactivity by bombardment with neutrons. He discovered that uranium is transformed into a new and hitherto unknown element which disintegrates with the production of positive electrons. Further experiments with this substance made it likely that we have here a quite unexpected element of greater atomic weight than uranium, which has hitherto been the highest in the periodic system of elements. The new element would bear the atomic number 93 or 94.

Physicists from a great many countries contributed to the discussion on cosmic radiation, among them Auger, Blackett, Compton, Hoffmann, Rossi, and Millikan. It is probably common knowledge to-day that this radiation has its origin somewhere in the universe ; its penetration is extreme, much greater than that of the most penetrating gamma-rays. In spite of the world-wide investigations on this subject that have been lately carried out the nature of these rays is still unknown. Experiments seem to show that cosmic radiation is a mixture of waves, comparable with the gamma-rays, and corpuscles, probably electrons.

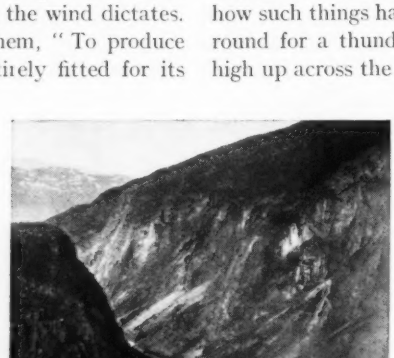
New particles such as the neutron, the positive electron, and the diplon have been discovered, and new elements brought into existence. Physics is full of adventure nowadays. All those who are interested in these problems may expect thrilling events in the near future.

Summer on the Hardanger Fjord.

By A. J. Harthan.

As announced on p. 277, the first prize in our Travel Competition has been won by Mr. A. J. Harthan for his vivid account of a holiday on the Norwegian coast. No unfamiliar country is here described, but the author gives a straightforward picture of the beauty and interest of the district, whether natural or man-made.

To some people there is a great fascination in arriving at a place by boat. They feel far more contented than when the journey ends in a humdrum way by train or car. Such people like to spend a holiday in boats, and when this happens to be wandering up one of Norway's fjords for the first time, there can be few other things that they can enjoy more. It was my good fortune to do so in a small open boat, seventeen feet long, as used by the Hardanger people. These native boats are perfect for their purpose; built with three planks on each side, they may be rowed or sailed as the wind dictates. A boat-loving friend exclaimed of them, "To produce anything so perfectly simple, so entirely fitted for its purpose, so cheap, and at the same time so beautiful, is genius," an appreciation that applies to much else that shows the arduous struggle with Nature that has made the Norwegian. To make a living in a land where two-thirds is bare solid rock is sure to produce that perfect balance and freedom from inessentials that typifies true beauty.



Maabodal glen, with spray-mist rising from the Voringsfos on the right.

Our two boats, named *Kari* and *Synnöve*, were both about forty years old but as sound as ever. We set out from Rosendal in the glorious weather we had signed on for. There was no wind, so we manned the oars until the heat made a bathe essential. Later an obliging puff of wind blowing up the fjord enabled us to travel on at a better pace. Unfortunately, in Norway puffs of wind seem to be of two kinds: they come and die away, or they come and keep on coming until you have had quite enough. This one petered out, but we managed to keep going by passing through the grand narrow entrance to the short Mauranger fjord and reached Sundal. Here in the little inn were the old Hardanger mirrors of coarse glass, which give most amusing contorted images, so ludricrous that some of us inscribed our occupation on the aliens registration card as pirates. Nobody feels the least bit like an alien in Norway! Our late arrival made no difference to the excellent supper provided by our host. Afterwards, at 11 p.m., we watched martins feeding their young in twenty-seven nests packed side by side beneath the eaves. High up behind us a ghostly light played upon the dim mysterious colours of a distant glacier breaking away from the eternal Folgefond snowfield. Next day we climbed up to this glacier. It is difficult to estimate the vast scale of these mountains, or appreciate the forces that packed such gigantic rocks together in the glacial moraines—but we saw a little of how such things happen. A sullen rumble made us look round for a thunder cloud; none was to be seen, but high up across the valley something was creeping slowly downwards, opening out like a fan until it reached the topmost fringe of birch trees which scattered down like midget skittles, proving that our supposed thunder was a fall of rock. Many waterfalls give the same impression; in fact some, though perfectly visible, appear as streaks of white solid rock until field-glasses reveal the water in motion.

On our way home we passed four girls with milk-churns strapped on their backs, going up to the cows on the high pastures. Very early next morning one of them brought to the inn a fountain pen we had dropped near the glacier, and not waiting to receive our thanks, returned to her work. We left a little present for her with the innkeeper. The character of the country people is shown also by the total absence of padlocks and even shut doors in most of the little saw-mills and boat building sheds that adjoin the road along the fjord shore. There is no need to waste time in careful stocktaking of tools and materials every Monday morning. So long as a thing works country people do not bother about inessentials. The picture of the local power house illustates this point. This "Heath-Robinson" jumble of wooden sheds, sluices, and water troughs looks ridiculous, yet it works all right. Notice the water-driven grindstone in the right

The power-house; very much home-made!

foreground. The same simplicity is seen in their gates. The rock-bound soil prohibits sinking posts deep in the ground except with great labour. Instead they are held upright and steady by a bar nailed across the top.

The mountain valleys of Norway are full of birds. We saw fieldfares and redwings nesting in alder trees by the rivers. Canary-coloured icterine warblers poured out their amazing song of harsh frenzy from the bushes beneath, in marked contrast to the flute-like trills of innumerable sand-pipers. Whinchats and wheatears crowded the open stony waste lands. Each cock bird conducted us across his private territory and handed us on to his neighbour alertly waiting for us. On the fjord seabirds were not very numerous, but each salmon net had some common, and a few lesser black-backed, gulls squabbling for perches on the floats. Willow warblers were everywhere, creeping about the bushes like small tawny mice. The abundance of this little migrant throughout northern Europe always fills me with wonder. Each year millions must perish on migration yet every spring they appear as numerous as ever. Robins, wrens, flycatchers, and pied wagtails were as tame and confiding as in England, but we missed the invisible song of larks above the English fields, the twittering of swallows sunning themselves on moss-grown roofs of ancient barns, and that rich chorus from woodlands at dawn when all but the wind is still.

Leaving Sundal we had a fair breeze out of the Mauranger fjord until a lull completely reversed the wind. By midday we had had enough of the choppy water and put ashore to wait for a calmer sea. After two hours conditions were if anything worse and our skipper cheerfully informed us that now at last the real holiday in boats was to begin. We plugged along till all the violent pains of pulling a pair of oars dancing about with the wind and the roll had numbed all feeling in the human, but now purely mechanical, engines. One boat hugged the shore of the deep bays, the other set a straight, much shorter, but painfully arduous course from headland to headland. The "shore-huggers" reached Jondal first, just before midnight, after a gruelling grind of some twenty miles. The innkeeper and his sons greeted us with cries of "Welcome to Norway," to which we were just able to make suitable replies before staggering off to bed.

The next week was spent in lazing about in boats, in expeditions into the mountains, and in eating great quantities of cherries; and, let it be admitted, in frequently wondering what variety of delectable dishes would appear at the next meal. The country housewife has a genius which transforms mundane materials like bread and cheese into different forms, each better than the last, and all appear on the Norwegian table at the same time. Bread varies from just bread to something far better, even to something that looks like cardboard and yellow india-rubber, though the English words give an absurd notion of the palatability of these excellent variations. Delicacies of the sea present themselves in tins, salmon and trout come fresh from the river, and to complete all the pot of real coffee is never empty.

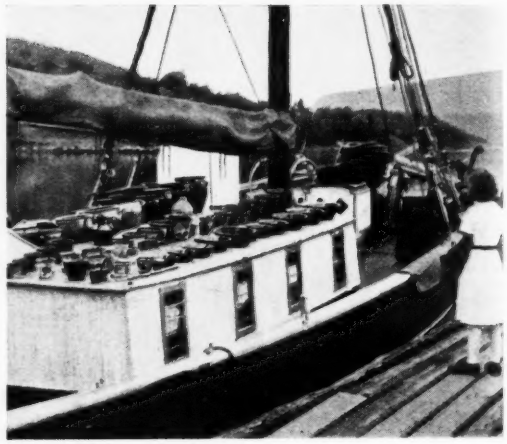
Jondal lies half-way up the Hardanger fjord. Inland a fertile valley of small farms winds up to the Folgeford snowfield. The road ends beneath a great round humped mountain called Saxeklep, which looks rather like our Ben Nevis. The family-worked farms take enormous trouble to make hay, their most valuable crop. Owing to the capricious weather the process may take as long as a month. After cutting, the grass is dried on wire fences and put into cocks each night by hand. Cows and sheep wear bells and are not handled with the help of dogs. There are many silver-fox fur farms. Fruit is abundant; some cherries with three inch stalks measured nearly an inch across. A tree on the road outside our inn had a ladder permanently set up against its branches, instead of the expected notice of a reward "for information leading to a conviction, etc." Red and black currants glistened from ancient bushes as big as hazel-nut trees. Other impressions are left by the bright greenness of small potato plots beside each gaily painted wooden house, and the sweet sickly smell of strawberry crates piled high on the steamers going down to Bergen at night.

Fish and yet more Fish.

Since the fjords are the highways for getting about, there are many small boats fitted up as shops. We saw one selling china, another live fish in a tank whose grid bottom allowed water to flow through as the boat moved about. The scooping out and slaying of chosen speci-

mens was not a very appetising sight. The same means of choosing a dinner may be seen in Bergen fish market. About thirty twenty-ton boats were catching brisling, a small fish like a sardine. A Government Fishery Research ship regulated the size and time when the fish might be caught. This seemed a very haphazard business, for at any hour of the day or night the boats might be chugging out to lay their nets, the thumping and popping of their Swedish oil engines echoing across the fjord like a thousand tom-toms. When in harbour at midnight, the babel of gramophones, concertinas, and always fine singing showed that theirs was a twenty-four hour job.

At the head of the Hardanger fjord lies the Maabodal valley and the Voringsfos, one of the finest waterfalls in Norway. The valley is a magnificent gorge ten miles long, getting narrower and deeper as it burrows into the mountains. The large-flowered, brilliantly coloured alpine flora was at its best. Moss-grown rocks were covered with the dainty, apple-blossom pink, "Twin-flowers" of the *Linnaea borealis*. Butterflies, like our ringlets, fluttered about on purple storksbills and geraniums. Dark blue monkshoods grew as high as spires of hollyhocks. As we were not botanists we could not name most of what we saw but this made little difference to our appreciation of the beauty of it all. The road climbs up along the cliff ledges of this valley, twisting and tunnelling in a most remarkable manner, until it reaches the Vidda, a tundra-like country five thousand feet above the fjord. At the head of the gorge a river suddenly disappears down a pit very much like a chimney, for the top is always smoking with a steam-like mist rising from the bottom of the fall a thousand feet below. A breeze of cold mist blew upon our faces as we turned the last mound of spray-drenched flowers that hid the falling water. Through a narrow opening, in dark mysterious gloom, lay a pit of thundering water. It was ten o'clock at night and the faded light gave our surroundings the murky darkness of some great cavern or the bottom of a well. Far above us a red sunset coloured the soaring pinnacles of its opening to the earth, a circle of blue sky across which some birds skimmed like midges. On one side a great rumbling mass of falling water numbed every sense but sight, on the other, a grey cloud of water-dust raced up the shaft. From the main fall whitish streamers drifted out and downwards as slowly and majestically as dense smoke swelling out in still air. These streamers show a curious paradox; their shape and form are permanent but everchanging. At one moment the whole streamer seems to be falling, at another separate rills of water appear to run down some tenuous but fixed framework. They press out like the streamers of rockets, their whiteness fading away as they meet the gloom and thunder of the mighty torrent rebounding from the very bowels of the earth. We try to analyse such things critically, to build up their varied parts in words, but behind all these workings of the intellect lies the mind of primitive man, feeling more strongly than we that such things are eternal, and perceiving in them the spirit of a god.



A floating crockery shop.

With this unforgettable experience our voyage of exploration was complete. We had reached the heart or Norway and learned to enjoy every moment, whatever the weather or our varied personal inclinations might be.

Dicarbon Gas.

Most people are familiar with the two usual oxides of carbon; carbon monoxide (CO) and carbon dioxide (CO_2). Probably only chemists, and not all of them, have heard of carbon suboxide (C_3O_2). Unlike its better known cousins, the suboxide is not formed through the combustion of carbon but has as its antecedent an organic compound designated by the formula $CH_2(COOH)_2$. Notice that if two parts of water ($2H_2O$) are removed from this product, known as malonic acid, C_3O_2 remains.

Carbon suboxide is a gas under ordinary conditions, and A. Klemenc of Vienna with his co-workers, R. Wechsberg and G. Wagner, have succeeded in decomposing the suboxide under properly chosen conditions at 200°C. to give carbon dioxide and a hitherto unknown gas, dicarbon (C_2). Dicarbon is a carmine-red gas which rapidly polymerises to a purple-red solid carbon. The polymerisation product is readily soluble in water, yielding a red solution. This product is still too new for much to be known about it.

Book Reviews.

Native Policy in Southern Africa. By IFOR L. EVANS. (Cambridge University Press. 6*s.*)

Western Civilisation and the Natives of South Africa. Edited by I. SCHAPERA. (Kegan Paul. 15*s.*)

These two volumes supplement one another so usefully that they might have been written in collaboration; and it would have been an excellent thing had Mr. Evans's sketch of native regulation and administration in Africa south of the Zambesi appeared in the same cover as the essays of Dr. Schapera and his colleagues.

Africa south of the Zambesi, excepting, perhaps, Southern Rhodesia, is confronted with a native problem more serious than exists in any other division of that continent. Not only is there the primary distinction of "white," "black" and "coloured," each giving rise to its peculiar difficulties, but the black with which we are here concerned—that is, mainly, the Bantu-speaking peoples who form the vastly preponderating element, in the population, outnumbering the whites in the Union by more than three to one—are by no means homogeneous. They differ in indigenous culture and social organisation *inter se*, and also in the degree to which they vary in attainment, social disintegration and outlook, according to the extent and mode of their contact with European civilisation. They live in towns or on farms or in reservations; some are detribalised, others live in family groups, while others, again, are under more or less tribal organisation. The general trend of development everywhere is in favour of the growth of individualism as against the traditional family or tribal solidarity.

How this situation, interesting to the student, but of grave import for the statesman and the administrator, came about may be studied in the pages of Mr. Evans's book. He traces the relations of white and black as expressed in regulation and law in each of the four provinces now forming the Union of South Africa, in the Protectorates of Bechuanaland, Basutoland, and Swaziland, in the mandated territory of South-West Africa, and in Southern Rhodesia. It is a story which begins with a conception of the advancement of the native by converting him into a "white" man, and has now reached the policy of "segregation," the complete separation of white and black, of which the best that can be said is that it has now admitted definitely the legal and official recognition of the principle of regulation of native affairs according to native ideas in appropriate conditions, thus regularising for the Union as a whole what had previously been practised in part.

The volume of which Dr. Schapera is editor is not a study of the native problem as such. It is inevitable, however, that it will be read in the light of discussion of that problem, for which, indeed, it provides valuable material. It is in form an ethnographical treatise or series of treatises in which the editor and a number of collaborators of recognised authority survey certain aspects of Bantu society as it stands at the present moment. That is, the authors make no attempt to reconstruct Bantu society and culture in its essentials as it was, but they show what it has become, and how the life of the native is now lived in the conditions which have arisen from European contacts. Thus the editor writes on present-day life in the reserves, Mr. W. G. A. Mears on the educated native in Bantu communal life, and Messrs. H. M. Robertson and J. D. R. Jones on the economic conditions of rural and urban natives respectively. Two essays which are among the most instructive in the volume, though in a sense the most academic, are those by Mr. Percival R. Kirby on the effect of western civilisation on Bantu music, and by Dr. G. P. Lestrade on European influences in Bantu language and literature.

Two essays, however, vary from this general outlook. The editor contributes an account of the old Bantu culture in order to give the reader orientation, and Mr. D. D. T. Jabavu reviews Bantu grievances, pointing out where, in the view of his people, present conditions, especially in relation to land and employment, hamper development and adversely affect tribal life.

Although, as has been said, the primary object of these essays is to describe present conditions, each contributor has been left to his own discretion in suggesting modification, and the editor himself in his introduction has pointed out where and why segregation fails and the difficulties in the way of a policy of adaptation, which is now coming into favour in certain quarters. While these comments and observations are made in a spirit which in no way affects the academic calm with which the contributors have approached their subjects, they add immensely to the assistance which these two books give towards an understanding of the problems which arise in the contact of two peoples of different, and in some respects incompatible, cultures.

A Modern Columbus. By S. P. B. MAIS. (Rich and Cowan. 7*s.* 6*d.*)

As New York is now within five days of London, the title of this book may at first appear a trifle presumptuous. But after a very few pages the most sophisticated reader will discover things about the United States to-day not a bit less surprising than those which greeted Christopher Columbus nearly five centuries ago.

The book consists of twelve descriptive talks broadcast by the author during a journey in the autumn of 1933. It involved working continuously for three months, the first part of each week being spent in travelling from one stopping-point to the next, followed by a round of visits and sight-seeing, and leading up to the lecture that was broadcast every Friday evening from October 13th to December 29th. In spite of the combined efforts of the National Broadcasting Corporation and the B.B.C., the transmissions were often imperfectly received by English listeners, who will therefore welcome a printed version. But quite apart from their interest to the wireless public, these talks have a permanent value in providing a vivid survey of American life at the present time. There are necessarily defects in a record compiled under such hurried conditions, but it succeeds throughout in reflecting the unbounded enthusiasm and vigour which are the essential characteristics of the American people. A quotation at the outset confesses that "the grass is always greener on the other side of the fence," and although Mr. Mais has painted everything he saw in exaggerated colours, this is actually an advantage, for everything in America *is* exaggerated. (He may be allowed his eulogies of their food, but his suggestion that there is no comparison between the "always brilliant" *New Yorker* and our own "too stolid" *Punch* cannot be allowed to pass unchallenged. Nor will anyone who has followed a season of American football agree that it is a better game to watch than rugger.)

Those who have caught this enthusiasm even from brief visits to the Eastern States will be glad to find the same note

in every city and state described by the author. It is emphasised in the many references to education and is particularly gratifying to the reviewer, who has sometimes wondered in rereading his own "Columbus—Undergraduate" whether its enthusiasm for America was more to be attributed to youthful exuberance than the actual conditions warranted! Whatever else may be happening under the "New Deal" there is clearly no weakening in the zeal which prompts thousands of Americans to wash dishes and stoke furnaces in order to "earn" a university education. Mr. Mais expresses a very proper doubt as to whether the student employment system is really a wise one, but he certainly gave a tip to a cloakroom attendant more gladly when he learnt that it would help this man to pass his Law Finals, than to a cloakroom attendant in a London theatre who "only glowers and extorts it as a right."

The many sides of American life touched on in this book are illustrated by photographs, and there are useful hints which will help the visitor to feel at home in America. Each chapter is followed by notes of geographical and historical interest. In this way the general sketch provided by each talk is not spoiled by too much detail, though the references are there for those who want them. The book should thus appeal to the traveller as well as to the general reader, though its chief value lies in interpreting the spirit of America. A proper understanding is more than ever necessary at a time when the United States is passing through a critical period in her history, yet it is probable that those who are prompted by this book to go and see for themselves will conclude that the sterling character of the people cannot fail to carry them through their present difficulties.

Rebel Destiny. By MELVILLE and FRANCES HERSKOVITS. (McGraw-Hill. 12*s.* 6*d.*)

The authors of this book introduce their readers to a country and a people that to the majority will be new and strange. The Bush Negroes of Dutch Guiana, it is true, are not unknown to science. Careful studies of them have been made, in particular, by German anthropologists. But they have received little attention from English travellers. They have not always been too easy of approach; but their culture, especially their decorative art as manifested in the carving of wooden objects, has proved well worthy of intensive study.

Owing to the necessity of importing labour in the early days of settlement, the population of Dutch Guiana became one of the most heterogeneous in South America. Among the peoples introduced from various parts of the world were a large number of negro slaves. These revolted some hundred and fifty years ago and, escaping from slavery, set up a number of communities in the interior. They recreated their native African culture and this they have preserved, subject to a certain amount of modification due to later contacts.

Dr. and Mrs. Herskovits, who have been engaged for some years in the investigation of negro culture, here give an account of the daily life, the customs and the beliefs of the negro communities situated on the Suriname River. In the pattern of their thought, as might be expected, magic figures prominently. In respect of this feature, as well as in its record of cultural status generally, this book affords valuable material for comparison with the less advanced members of the negro communities in other parts of America.

The Romance of Research. By L. V. REDMAN and A. V. H. MORY. (Allen and Unwin. 4*s.*)

This fresh, optimistic little book is one of a series, entitled "A Century of Progress," which comes from Baltimore. Its main concern is to illustrate graphically what great benefits to mankind and what great industries have accrued in our day from discoveries in science made, not with an eye to the main chance, but solely in the furtherance of a research-worker's job. "Our great need at the moment is for industry-making discoveries. Let us remember Faraday's electromagnetic induction, Maxwell's Hertzian waves, and the Otto cycle—each of which has provided employment for millions of men; and, although it is an old story, let us also remember that the economic value of the work of one scientist alone, Edison, has been estimated at three thousand million pounds." So Sir James Jeans at the close of the Presidential Address at Aberdeen this year. And so, in other words and with a wealth of illustration on the same topic, our authors. The subject-headings of some of the chapters will indicate the line they have taken: Research, its viewpoint and method; enslaving the inanimate; deeper understanding, greater power; new requirements, new materials; catching up with material progress. The book abounds in excellent examples of the great in industry and life arising from the small in research; there are many pithy points about pure and applied science. There is, further, a good deal of technical information worth having for its own sake, especially with regard to the manufacture of bakelite materials, of which the authors have first-hand knowledge.

Science and Monism. By W. P. D. WIGHTMAN. (Allen and Unwin. 15*s.*)

Dr. Wightman's book, as Sir Percy Nunn points out in a short foreword, is a welcome sign that the philosophical bearings of scientific discoveries are beginning again to excite general interest, even in Great Britain which is as a rule less easily stirred by this line of speculation. It is also a volume in a new "History of Science Library" edited by Professor A. Wolf of University College. The initiation of such a series is again a movement heartily to be welcomed. No part of history has more to teach us; no part is less adequately represented in the current schools and courses of historical study. It was the want of any book in English treating of the most general aspect of science which prompted Dr. Wightman to his work, which was in the first case a thesis presented to the University of London for his Doctor's degree. The republication in this more complete and criticised form is fully justified. "We are confronted" he tells us in the Preface "with a world in which a hedonistic materialism co-exists with a somewhat nebulous idealism; a world whose churches are half empty but whose newspapers and bookstalls testify to a growing interest in religious questions. Strange to say, the partisans of all these conflicting ideals call upon the same body of knowledge—modern science—as the authority for their views." It was to bring some clearness and consistency into this chaos that Dr. Wightman took up his pen. He rightly commences with the history of the leading ideas which men have entertained about the nature of knowledge and the unity of nature from the Greeks downwards. The treatment of the classical period is slight, but there is a full and searching account of Spinoza's monism and a very useful recall to Leibnitz. For the majority of readers, however, the interest of the book will lie mainly in the later sections in which the author deals with the concepts of

modern science, and brings together their numerous tendencies towards a monistic, or at least a unitary view, of all the phenomena both of animate and inanimate Nature. His mind is receptive to a high degree but not uncritical. He hails Haeckel as a master mind in his generalising conception of biology, but parts company with him when he declares that "the problem of consciousness is the business of physiology." We must follow Haeckel in seeing in all life a continuous and developing sequence, and in attaching some form of consciousness to all living things. But we cannot treat consciousness as part of physiology, because we cannot observe our own states of consciousness nor indeed those of any other creature. Dr. Wightman is quite prepared to follow the biochemists, as far as they can go, in tracing the emergence of living from non-living things. He only objects here, as elsewhere, to the intrusion into the discussion of the idea that the new emerging thing is "nothing but" the lower category from which we are tracing it. "We may conclude therefore that 'mind' has arisen and developed *pari passu* with organism. If organism can be accepted as one with inorganic nature, then so can mind, seeing that, consciousness being always excluded, it is merely one of the activities which characterise all living creatures." It will be seen that Dr. Wightman is largely under the inspiration of Professor A. N. Whitehead, whom he gratefully acknowledges as his master, together with Alexander, Lossky, Lloyd Morgan and J. S. Haldane. He should have added to this list General Smuts whom he frequently quotes, and Meyerson to whom he gives one, quite favourable, reference. Meyerson indeed is the man, in European thought as a whole, who has conducted a similar enquiry to Dr. Wightman's most persistently, most clearly and most persuasively. We are sure that Dr. Wightman will regard the comparison as a compliment.

From Olympus to the Styx. By F. L. Lucas and Prudence Lucas. (Cassell. 12*s.* 6*d.*)

The average reader vaguely associates the word Olympus with a Greek mountain which may or may not have something to do with Olympia, and the word Styx with a river of the underworld. This admirable account of a journey through Greece will make it clear to him that the home of the gods and the scene of the Olympic Games are far apart, and it will reveal the surprising fact that there is a real river Styx in the north of Arcadia. It will also tell him that Greece had an eventful mediæval history long after the age of Pericles and long before the coming of the Turks. Frankish ruined castles are seen as well as the battered survivals of the classic past.

The authors entered Greece by the overland railway route and spent their first night at Salonika. Thence they walked or drove through Thessaly, Phocis, Athens and Attica, and the Peloponnesus, visiting as well the islands of Aegina and Delos. Their route included a great part of "old" Greece; but, whether from choice or from lack of time, they saw very little of Bœotia, Eubœa, Achaia, or Elis (except Olympia). When they come to a place they follow the method of Pausanias, in his later books, and entertain us with a host of anecdotes about it, from the Heroic Age to the War of Independence. The erudition they display would be overpowering were it not relieved with a fascinating style and a quiet but insistent humour. Their subject-matter has a formidable bibliography, but they have succeeded in presenting the familiar scenes from a new angle. They found the white marble of the Propylæa and of the Erechtheum more satisfying than the fabric of the Parthenon itself, which has been oxidised to a rusty brown, mispraised as "golden." The "Theseum" persists in looking like a modern reproduction, "in the style of the British Museum." Tiryns appeared to disappoint the travellers, but the "Treasury of Atreus" at Mycenæ, called for a second visit. Poets will be sorry to hear that the Castalian spring at Delphi was a mere trickle; but the Fountain of Peirene at Corinth was still going strong.

The authors appeared to have sampled every mode of conveyance except the aeroplane. Possibly the name of the Icarus Air Line put them off. They used the train between Corinth and Athens, thus avoiding the "Evil Ladder," where the robber Sciron performed on his victims, and the dull town of Megara, whose chief claim to fame, apart from being the birthplace of a Euclid who has nothing to do with the *pons asinorum*, is that it founded Constantinople, or rather its predecessor Byzantium. The postal cars now common all over Greece were always cruelly overloaded; on one occasion a dog sat precariously on the bonnet (the authors have a lot to say about Greek dogs). Steamers were habitually hours overdue, and they had a trick of sailing through the Gulf of Corinth in the dark. Every kind of sleeping accommodation was experienced, from the hotel at Levádia, with running water in the bedroom, to the grisly room in an Arcadian village, which harboured "every kind of devouring creature short of the crocodile."

For a mountainous country Greece is singularly devoid of inland lakes. Although Frazer has vividly described the scenery of Lakes Pheneus and Stymphalus, it is a pity that the authors did not extend their tour so as to give us some anecdotes about these Arcadian beauty-spots. It is also disappointing that when they went to Marathon they did not look at the great artificial lake recently built as a reservoir for Athens by the Ulen Company, and tell us if it is æsthetically as successful as Lake Vyrnwy, or whether it looks like the Welsh Harp.

Viewing the battlefield of Chæronea, the authors say that no one can grasp Greek history imaginatively until he has seen with his own eyes Greek geography. One might amplify this statement by saying that the only proper way to learn Greek or any other history is to study the country's topography first. If a boy is given a copy of Pausanias and a large-scale map of Greece he will be able much better to appreciate Herodotus and Thucydides; Marathon and Salamis will not be mere names to him.

Like every other writer on Greece, the authors appear to have been troubled with the difficulties of transliteration. For instance we find Cephisía (p. 164), but Kalabáka (p. 52) and Kalamáta (p. 281). The pleasant suburb of Athens is universally known as Kephisía, or even Kiphisía. Again *Pi*sistratus (p. 157), but *Pei*rene (p. 123) and *Pei*raeus (p. 179); on the map, by the way, the place is called Piracus (*sic*). Surely the port of Athens is well enough known as the Piræus. Again, why Lebadea (p. 94). when the town is commonly known as Levádia or Livádia, while we find Monemvasía on p. 271? These examples rather mar the effect of a delightfully written and scholarly book; but we do not by any means urge strict consistency in transliteration, as otherwise we get such monstrosities as Enneacrunus on the one hand (Latin method), and Plataiai (Greek method) on the other. Samuel Butler makes some apposite remarks on the subject in the Preface to his *Authoress of the Odyssey*; but, as anything that genius says makes the average classical scholar see red, it is feared that he has spoken in vain. Besides, the very learned book, sponsored by the British School at Athens, on the Temple of Artemis Orthia at Sparta spells Lycurgus in two different ways in the same volume. Finally it is to be deplored that a work of the quality of *From Olympus to the Styx* is not provided with an index.

Scolt Head Island. Edited by J. A. STEERS. (Heffer. 15*s*.)

Such a book as this, interesting at any time, is doubly important at a period like the present, when so little of the English coast-line is being allowed to remain in its natural state. Mr. Steers is to be congratulated on getting together so competent a team to organise a task of national importance in the sphere of natural history. To the public mind, Scolt Head is simply a bird sanctuary, and Miss E. L. Turner scores in having the chapter on the birds allotted to her. A fascinating chapter it is, too, and Miss Turner's account of the terns, their specific and individual peculiarities, and their mating and nesting habits, will be of interest to all readers, being by no means solely a scientific record. It is impossible here to mention all the detail with which the island has been treated ; but special reference is due to the Editor's work on the Physiology and Evolution of the Island, and to Mr. V. J. Chapman's chapter on its Ecology—both particularly interesting on account of the ever-changing nature of the field concerned, and both carried out with the competence we should expect. No mention of Scolt Head can be made without a reminder of the splendid work of that vigorous body, the Norfolk and Norwich Naturalists' Society, and of the National Trust, under whose kindly protection the fauna and flora of the island are left in peace.

A very pleasant loose jacket, designed by Soman of Norwich, covers a rather unworthy binding. The plates and maps are absolutely first class.

The Naturalist on the Prowl. By FRANCES PITT. (Country Life. 5*s*.)

Miss Pitt is well known as an expert photographer and field naturalist. In this little volume she lucidly explains her methods and gives invaluable hints to beginners—and others. She emphasises the importance of wearing suitable clothes when "on the prowl" ; they should be as inconspicuous, and, we may add, as old, as possible, and should keep out the wet. Field-glasses she prefers to telescope for ordinary field work, and in our opinion rightly, though the latter is sometimes useful, e.g., for watching more or less stationary birds on reservoirs, or on a large expanse of impassable marshland.

Miss Pitt illustrates from her own experience the necessity of keeping still, and of approaching your quarry slowly, even on hands and knees. A note-book is a *sine qua non*, but to make your notes in it at once, while on the spot, is equally essential.

The author's instructions to the intending bird or animal photographer are admirable. They include advice as to choice of camera and lenses, with their appurtenances, and the erection and material of the hiding tent : Miss Pitt finds that this usually need not be camouflaged at all so long as it is not too conspicuous. And the tyro is warned against trying to photograph a bird that is nervous or over sensitive to disturbance : neglect of this precaution has in times past done very ill service to some of our rarer species.

Miss Pitt, in the descriptions of her adventures in search of her quarry, points out that the motor car is as great an advantage to the bird-watcher as it is to the big game hunter. She was able to watch and photograph the display of blackcock from her car at a short distance : so long as she stayed inside, the birds took no notice of the motor. The author protests strongly against the faking of Nature photographs, e.g., by the suppression of offending high lights from the print, or the removal of unpleasing objects from near a bird's nest in order to get an " artistic " picture. " The ideal of the Nature photographer should be to show the bird in its actual environment." We may add that " faked " pictures are scientifically useless. Miss Pitt admits our debt to the " museum man " in the past, but says that nevertheless the trend of research in zoology and ornithology has to-day " moved from the aroma of camphor and preservatives to the clean open air." This book aptly illustrates the truth of her contentions. Miss Pitt is herself one of the most distinguished exponents of modern field work.

The photographs are, of course, excellent. We especially admired one of a dew-spangled spider's web which shows how much beauty there is in an everyday subject.

Features in the Architecture of Function. By JOSEPH BARCROFT. (Cambridge University Press. 20*s*.)

Most physiological monographs are of interest only to the specialist, but this book of Professor Barcroft's ought to have a much wider appeal. There is no lack of detailed description of experimental results, but they are put in, not to show that the author has read all the literature, good, bad, and indifferent, but in order to illustrate and develop certain general biological principles. The first and most important of these is Claude Bernard's dictum that constancy of the internal medium (in practice the blood) is the necessary condition for free life. There is here an abundance of facts to illustrate the principle. From them the interesting conclusion emerges that the lower organisms can survive quite large changes in their internal medium without disaster. The higher up the animal scale, the more complete and elaborate is the mechanism for preserving constancy and the more disastrous is any deviation from it. This shows what significance is to be attached to the term " free life." What endows the higher organism with the greater freedom is the nervous system and it is the nervous system that suffers first and most when the constancy of the internal environment is disturbed.

This is the main theme ; the rest of the book may be described as variations on the theme. A few of them can be mentioned. The constancy of the internal medium is not rigid and static but dynamic, it can be altered in adaptation to varying needs, as, for instance, for violent exertion or lack of oxygen. If one factor alters, others must alter too, or the balance will be upset, therefore, as the author puts it, " every adaptation is an integration." Another topic, entitled " the principle of maximum activity " is that an organ, such as heart or kidney, is designed to cope with conditions of maximum activity or " peak load " and under average conditions will be " running light." Here as elsewhere in the book it is impossible to avoid thinking of engineering parallels. The physiologist is like an engineer examining the products of a rival firm. Mostly he is amazed at the adequacy and ingenuity of the design but sometimes he is puzzled by some feature he cannot understand. As Professor Barcroft says, " why is there only a single heart ? " Any sensible engineer would have put in at least one small auxiliary, but apparently in the whole animal kingdom only the Cephalopods have done so.

The author has a very pleasant method of describing experimental results, rather as if he was showing one round the laboratory and explaining what everybody is doing. It is a pity that the general principles underlying the work are sometimes given in a hasty whisper in the corridor, so that the visitor has to be on the alert not to miss them.